GRADUAL REDUCTION

MILLING.

A TREATISE ON THE

ART OF MODERN MILLING

BY

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INTRODUCTION.

Where the reader is familiar with the general purposes of the writer, it is much easier for him to understand the details of the work. This book is intended to be one which has distinctively to do with milling and milling methods, but not with milling machinery. It is constructed on the idea that a mill is intended to make money, and the methods here given have in mind the production of the largest quantity of flour out of a given quantity of wheat, and of a quality such as will give it a good standing in the market. In general terms this is the purpose of the book.

As to the plan: There is first a little milling history, and then a little more which has to do with the development of milling methods. After this there a e a number of chapters given to the general consideration of milling operations, which is followed by "A Journey Through the Mill," which considers the principles of milling in a more detailed way than in the previous divisions. After the journey th.ough the mill, mills of various sizes are considered one at a time. The consideration of mills of specified capacity gives opportunity for exact statements, and as the mills are larger, it may be shown how the details are worked out more closely. It may be said, however, that the diagrams given for the smaller mills might well be used for larger ones where the necessities of the case do not demand a more elaborate arrangement. The seventy barrel mill might be arranged for one of two hundred and fifty barrels per day by an increase in the amount of reduction and separating machinery. On the other hand, a fifty barrel mill might be arranged from a hundred barrel diagram by making corresponding changes in the machinery.

In future editions of this book the writer designs to make such changes and additions as will keep it abreast of the times.

LOUIS H. GIBSON.

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THE HISTORY AND DEVELOPMENT

OF

GRADUAL REDUCTION MILLING.

CHAPTER I.

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In a work of this kind, which has only to do with the milling of the present time, it is hardly necessary to consider the past, except in so far as it has to do with the development of recent methods. History, for its own sake, will not be considered. The history of milling, to him who cared to write it, would be the history of the reduction and purification of cereals for bread making purposes. The history of purification in general, without special reference to middlings, would be the complete history of milling. The primitive savage who, in hammering out his grain on a rock, stopped to pick out a bug or a stick, expressed his idea of purification, and, for the time being, was satisfied with it; but as he looked around, he advanced, he discriminated more closely as to what he should eat or wear; he took out more of the impurities from his flour; wore better clothes, and has been doing the same thing ever since. His first efforts expressed the germ idea of milling; that is, purification.

As this work has to do with middlings milling, as now understood, it may be well to give the history of its development, beginning with the time when the value of middlings, as a milling product, was first recognized.

Ignaz Parr is spoken of as the father of high milling. He was born July 22nd, 1778, in Tattendorf, Lower Austria, and died Sept. 6th, 1842, in Lichtenworth, Austria. Parr made the experiment of re-grinding the separated grits, and made a flour which he called "Extract Flour;" and such was the demand for this flour that he could not supply it. He

purified the grits by hand sifting. After various experiments, he constructed, with the aid of a cabinet maker by the name of Winter, the first purifier. Fig 1 is a cut of Parr's machine. *A* is the hopper from which the broken grains fall into the purifier; *O* is an opening through which a current of air is drawn in upon the falling middlings. The heaviest fall through the division *B*; the next heavier fall at *C*. What falls through *B* encounters a current of air from *O*, which carries the lighter to *C*, and the still lighter is carried over to *D*. Thus the currents separate the middlings into three grades.

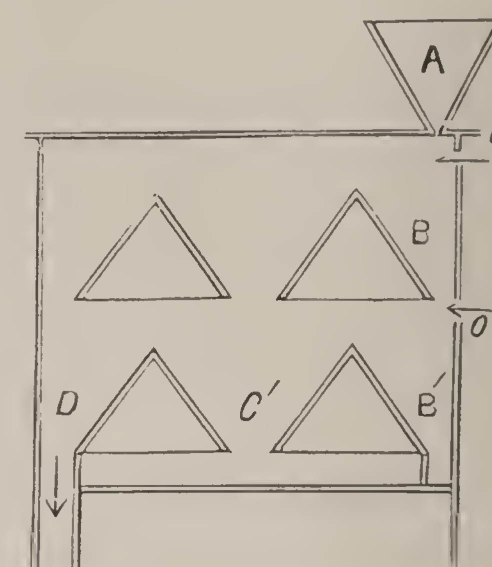


Fig. 1.

Down to the beginning of this century, the construction of flouring mills was extremely simple. There was a single pair of millstones and a single bolt of which the motive power might be wind, water, horses or cattle. Everything else must be accomplished by manual labor; and instead of elevators and conveyors there were shovels, barrels and tubs. In the early part of this century the first decided improvement resulted in the process of high milling which had its origin in the neighborhood of Vienna. This is shown from the fact that in 1807 a product was sold in Austria and Germany under the name of Wienergries (Vienna middlings), which shows clearly that high grinding was in practice. In those days high grinding was very simple. The millstone broke the wheat, the meal passing into a bolting box, which was a box with a screen under it, at the end of which stood a man with a riddle to separate the bran from the middlings, which was brought against it. Another man then took the separations of the middlings in hand. He stationed himself between two doors or open windows where there was a draft of air to which he exposed the middlings while shaking on a sieve. To a certain extent the bran was blown away and the middlings were afterward ground by themselves and the bolting done on another cloth.

Another method was as follows: The coarser particles were separated by agitating tubs or boxes having sieves across the bottom, the sieves being commonly made with hair. The bran worked to the surface because of its lightness and was, from time to time, separated by means of a little shovel, leaving the middlings at the bottom.

The development of high milling in Budapest was brought about in a peculiar way. The mills of that section were run by current wheels, that is, the water wheels stood out in the current and in that way transmitted the power to the mills. It so happened at one time that they had extremely low water, so low indeed, that the mills could not be operated in the usual way. The wheat could not be reduced at a single reduction, and, as an expedient, the experiment of reducing the wheat gradually by the millstones was undertaken. To the surprise of all who tried it, the flour was of most excellent quality, so good indeed as to lead to other experiments which developed high milling.

Previous to the introduction of the purifier in this country, the ingenuity and skill of the miller was devoted largely to the end of reducing his wheat without the production of middlings. Everything that was done for the buhrs, their speed, their dress and their general handling had this one object in view. Middlings were regarded as a product which was unavoidable in the later years of the old process of milling; and, as such, there were efforts made to derive something more than feed from this material. For many years previous to the introduction of the purifier, middlings were regarded as a material from which flour of an indifferent character might be made.

Oliver Evans expresses himself on this point in the last edition of 1836, as follows: "Although we may grind the grain in the best manner we possibly can so as to make any reasonable dispatch, there yet will appear in the bolting a species of coarse meal, called middlings and stuff, a quality between superfine and shorts, which will contain a portion of the best part of the grain, but in this state they will make very coarse bread, and consequently will command but a low price. For this reason it is always profitable to the miller to grind and bolt them over again, and to make them into superfine flour and fine middlings. Middlings are generally hoisted by tubs and laid in a convenient place on the floor in the mill loft near the hopper boy until there is a large quantity gathered. When the first good opportunity offers, it is bolted over, in order to take out all that is fine enough to pass through the superfine cloth." Thus we see that they were dusted. "The middlings will pass through the middlings cloth, and will then be round and lively and in a state for grinding, being freed from the fine part that would have prevented it from feeding freely. The small specks of bran that were before mixed with it being lighter than the rich round part, will not pass

through the middlings cloth, but will pass on to the stuff cloth. The middlings will by this means be richer than before, and when made fine may be mixed with the ground meal and bolted into superfine flour." Here we see that the middlings were purified on the reel, and were afterward ground and bolted into what was then called superfine flour. It will also be noticed that they did not wish to make middlings, but as, in spite of all efforts to the contrary, they would make a small quantity, the next thing to do was to make the best of it.

A translation of a description of the mills of St. Maur, in the neighborhood of Paris, made in 1859, speaks of "the part next to the husk, that is to say, the hardest part and the most refractory to the millstones, but at the same time the richest in nitrogen and the most sensitive to the action of the leaven. It is scarcely a hundred years since this precious article of food has been in use. Previous to that time was it not only not sought after, but it was spurned with scorn under the contemptuous name of 'Champagne' flour. A royal ordinance in 1658, under the severest penalties, prohibited its use for human food and consigned it to the cattle." We notice again that they speak of the part which is refractory to the millstones. They would reduce it if they could.

During the later years of milling by the old process, it was not an uncommon thing to take that portion of the middlings which had passed through a No. 6 or 7 cloth and re-grind them on a buhr by themselves. This produced a grade of flour which stood between the first flour and the low grade. Its value was so much below the regular wheat flour, however, that no effort was made to increase its quantity. The earlier efforts at purification in this country were by blowing a blast into the reels in various ways. This was the foundation idea of the old Cochrane patent, which was granted to Coggswell & McKiernan, June 12th, 1860.

The first account that we have of absolute high grinding was at Northfield, Minn., in 1866. A farmer asked that some of his wheat be ground in that way, and without particular regard to the yield, the flour was produced, which, when examined by the miller, proved to be of most excellent quality. The owners of this mill became convinced that high grinding was the coming system, and they set to work to devise means of saving the large middlings and perfecting the system. Many different ways were tried with more or less success, but yet their experiments were not satisfactory. One method tried was to blow a blast of air

through a falling stream of middlings, but the middlings were not sized and this was abandoned as impracticable. Then the middlings were run into an eight-sided reel, and a blast of air blown through it. This plan was the most successful attempted. Another experiment was to run the middlings into a pile and let the impurities come on top. Flour was made from middlings in this mill and kept in stock as its best flour.

In 1868, Nicholas and E. N. La Croix, at Faribault, Minn., were operating a machine which was described as a box with a sieve on top of it and a blast of air under the sieve. This is the earliest account that we have of the use of a sieve and air current for the purification of middlings in this country. It is evident, however, that the idea of this machine was developed from those of French design and construction.

In February, 1870, E. N. La Croix described to Mr. Geo. H. Christian, manager of the Washburn mill of Minneapolis, a machine for cleaning middlings which he had seen operating in France, and solicited an order from him to build such a machine, and he accepted La Croix's proposition to build it on trial. However, this machine was not ready for use until some time in 1871, after which time it was run regularly for several weeks. The success of this machine was sufficient to indicate its great value.

Mr. Christian ordered another machine, the mechanical details of which were somewhat different, though the underlying principles were the same.

As this purifier was subsequently the cause of one the most bitter and stubbornly contested battles of the whole purifier war, a description of its principal features will be of interest. The frame was about six feet in length, nearly the same in width, and was enclosed in the manner usually followed in building such machinery. There were two sieves, placed side by side, driven from the same shaft, and separated from each other by a partition which divided the air chamber above the sieves longitudinally into two compartments, and extended from the top covering of the frame down to and below the level of the sieve frames. There was an exhaust fan on top of the machine, and each of the air spaces above the sieve communicated with it through separate openings fitted with valves, so that the force of the air current through the cloth o either sieve could be varied at will. The usual provision for the admission of air below the sieves was made. At the head of the machine, some distance above the sieves and arranged transversely to them,

was placed a grading reel clothed at the head with finer silk than the tail, having its conveyors and spouts so constructed as to deliver the material coming through the fine silk to one sieve of the purifier, while that coming through the coarser cloth was fed to the other. The purified middlings from these machines were ground on stone, the meal was bolted in separate reels provided for the purpose and the flour mixed with the first flour, producing a grade the demand for which was ten times greater than could be supplied, and which sold for fifty cents per barrel more than the best price obtained for the product of the mill before the improvements were made.

The history of the marketing of the first product of patent flour is pertinent in this connection. As commonly understood it is as follows:

Near the close of 1871, Mr. Archibald secured a La Croix purifier, and, taking it into the attic of his mill at Dundas, began to experiment. After much labor and continual trouble, 100 barrels of middlings carefully prepared and cleaned were finally accumulated and reduced to flour. A sample was sent by express to Plummer & Co., of New York, who had been handling the firm's flour, with the request that it be put in the hands of a good baker, and the flour and bread from it exhibited at the corn exchange. When the flour was shown there those who saw it could hardly be made to believe that it had been made from spring wheat. The hundred barrels were divided and sent to New York and Boston. The success of the experiment in marketing this flour justified its manufacture as a regular grade. In a few months the spring wheat patents had advanced three dollars a barrel over and above the price of their former regular grades.

Before the close of the year 1872, patent flour was selling for $14 in New York, and for several years the price varied but slightly. For two or three years the price of wheat fluctuated between sixty cents and a dollar and twenty-five cents a bushel, but the price of flour never changed, $10 at the mill being the fixed figure. It may readily be seen that these were the palmy days of milling, and that the foundations for the great milling fortunes of the Northwest were laid.

The winter wheat millers gradually took up with the purifier idea. In the meeting of the Millers' National Association at Toledo in July, 1873, we find that many millers of that section were engaged in discussing these machines. In February, 1874, at the meeting of the National Association at Chicago, this matter came up for discussion in a regular

way. Mr. Kern, of Milwaukee, who can hardly be spoken of as a winter wheat miller, however, mentioned the fact of his having a purifier in operation in his mill, and that he had just purchased eight others. Several of the winter wheat millers spoke during this discussion favoring the system of the purification of middlings, though it was evident that the adoption of middlings purifiers was by no means general at this time. They were still regarded as being in the experimental stage by many millers. It is not clear to whom, among the winter wheat millers, belongs the honor of having first introduced the purifier. It is a matter which is still under discussion.

The use of rollers in doing the work of millstones and in displacing them, dates back to the year 1820, when Collier of Paris, Bolinger at Venice, and Helfenberger in Switzerland, erected flour mills fitted with rolls instead of stones. These mills, however, did not succeed, though it is alleged that the fault had to do with the machines rather than the system of reduction by rolls. In 1830 Mr. Sulzberger, of Frauenfeld, Switzerland, succeeded in constructing a roller machine on a more improved system than the others. He established a company to introduce them throughout the continent of Europe, and many mills were actually built in Milan, Venice, Mayence, Stettin, Leipsic, Mannheim and Pesth; and for a time it appeared with great success, yet the fact is, that nearly all of these mills failed or adopted the old system of grinding. The cause of this failure was ascribed to the fact that it was impossible to find a sufficient number of skillful and intelligent workmen to operate the mills. A proof of this is found in the fact that one of the earlier mills which was built in Pesth, the Pesther Cylinder Mill, succeeded and continued to work this system with great profit. The Sulzberger machine consisted of three pairs of rolls arranged one pair above the other. Each roll was six inches in diameter and contained two hundred grooves in its circumference. The motion was differential, the usual speed for the slow roll being two hundred and sixteen, and the fast roll two hundred and twenty-nine. Rolls were used to break the wheat and the middlings, before they were used to reduce the middlings into flour.

It would appear that the first complete roller mill was the reconstructed Pesth Cylinder Mill, which was working in 1867. This mill had two hundred and ten pairs of rolls arranged in five sections. Two of these sections were arranged for the production of middlings and the other three for reducing the middlings into flour. As a mill which used rolls to re-

duce wheat and to grind middlings as well, this mill long had the monopoly. Until 1864 only one mill in Venice, one in Switzerland and another in Germany had adopted this system on a smaller scale. However, the Pesth mill seems to have been the first prominent success in this way.

It would appear that a mill designed by Naeff, of Pesth, was the next successful roller machine which came prominently into use after the Sulzberger. It was manufactured by Escher, Wyss & Co., of Leesdorf, near Vienna. This was in 1864. It was a four high mill, single rolls being placed one above the other.

Early in 1874, Mr. Wegmann, of Naples, brought out his porcelain roll and introduced it in various stone mills of Pesth. It was originally used for sizing middlings rather than reducing them to flour. Previous to 1874, rollers for the reduction of wheat and middlings were not generally used even in Austria and Hungary, the cost of a complete set being from a thousand to twelve hundred dollars. In 1875 rollers began to be used extensively in German mills, and at an exhibition of milling machinery in 1875, in Vienna, ten firms were represented, and at another exhibition at Nuremberg in 1876, fifteen roller mills were exhibited.

Now, while it would appear that the system of roller milling was generally understood for many years previous to its general successful introduction, however it was only during 1875 that the roller flour of Pesth began to achieve a world-wide reputation, or in fact was generally appreciated outside of that country.

The first roller mill in this country was the hundred-barrel experimental mill built in one end of the Washburn "C" mill in the winter of 1878–9. It contained sharp corrugated rolls, smooth iron rolls and porcelain rolls, and made three regular grades of flour at five reductions. The success of this mill led to the general introduction of rolls into this country. This mill is generally spoken of as the experimental mill, and we of this country are disposed to take a great deal of credit to ourselves in the matter of roller and gradual reduction mills. From the history given above it must appear that we are wrong in all this, and that we are justified in claims of invention only in so far as applied to the adaptation of this system to the automatic mechanical arrangements of American mills. It would appear from the present practice in American mills that the nearer we approach Hungarian methods as a system, the more successful and profitable is our milling.

CHAPTER II.

DEVELOPMENT OF NEW PROCESS AND GRADUAL REDUCTION METHODS—PURIFICATION THE CENTRAL IDEA OF MILLING—PURIFICATION ORIGINALLY AN EXPEDIENT IN HANDLING MIDDLINGS—THE PURIFIER AS THE REVOLUTIONIZER OF MILLSTONE REDUCTIONS—THE PURIFIER AS A REVOLUTIONIZER OF SEPARATIONS—THE PURIFIER DEVELOPS GRADUAL REDUCTION—PURIFICATION THE PATH OF PROGRESS IN MILLING AFFAIRS.

In the previous chapter we have a few facts in regard to the development of new process and gradual reduction milling. It has to do with facts independent of the reasons which led to the development of those facts. We read that the middlings purifier came into use at a certain time and that certain roller mills were in successful operation at certain other times. There was a reason for the introduction of the purifier, and for the development of gradual reduction methods. There is a distinct relation existing between the purifier and the latter methods of reduction.

In order that this may be made clear it may be well to consider, in short form, the reason for middlings milling—the reason why it is preferable to reduce wheat to middlings rather than directly to flour. It has already been said that the central idea of milling is purification. Middlings, as we have seen, were originally a troublesome material to the miller. His endeavors were in the direction of reducing the proportion of such stock. Having reached the limit of possibilities, and a considerable portion of middlings still remaining, there was a lurking thought in his mind which afterward took form in the purification of these middlings. As the miller of the earlier days saw this stock, examined it, tasted it and knew its richness, he could not but think, if he thought anything about it, that here was a material which should be utilized in a more profitable way than that of selling for mill-feed. It was not at all uncommon to see millers running this stock over a No. 6 or 7 cloth and then re-grinding its products. This was one of the earlier practical forms of middlings purification in this country.

While the process of purification which developed as an expedient for the taking care of a material which the miller could not but produce, however close he might grind with his millstones, the handling of this material developed an entirely new principle in milling. The purifier not only took this material and rendered it more valuable than feed, but more valuable than the highest grade of flour formerly made. This being so, an increase in the production of middlings was the next work of the miller. Why and how could the purifier do this?

The process of purification commences with the wheat, and the purity of the flour is largely influenced thereby. If it were possible to entirely remove all of the impurities of the wheat berry previous to its reduction, the purifier never would have been used; it would not have been necessary.

As purification could not be complete as a wheat cleaning operation, as the impurities were something more than foreign substances—something more than external attachments or coatings—it was necessary that the wheat be broken and that these external and internal impurities which were a part of the wheat berry be removed. The reduction machinery having partially detached such impurities, it remained for a machine to be devised which would separate such stock from the reduced material. Such a machine was realized in the middlings purifier. While the wheat cleaning apparatus removes the foreign impurities, and those which are readily detachable from the berry itself, the middlings purifier is the wheat cleaning apparatus which removes the impurities which are not foreign to the wheat, which are not detachable from the grain itself excepting subsequent to its reduction. The introduction of the purifier revealed a new principle. It more than accomplished its original purpose. While the original aim was that it should act as an auxiliary—a helper to the old process—it became the father of an entirely new idea and new principle in milling.

The natural thing to do, after first witnessing their work, was to raise the millstones, to grind higher, which was done. Next the miller observed that by taking off feed he could make more middlings. Then he reduced the proportion of land on his buhrs, and finally he reduced their speed. While previous to the development of the purifier the millstones were grinding from eighteen to twenty-five bushels an hour, their speed was reduced to one hundred and twenty and thirty and their

feed from the above to six, seven and eight bushels an hour, and all with the view of making more middlings.

It would be difficult to say when the first pair of smooth rolls was used in this country, or for what purpose. Among the first uses to which smooth rolls were put was the breaking of the wheat previous to its reduction by millstones. Yet it could hardly be called a breaking, as its tendency was to a slight crushing, and it required an examination to assure one that it had been operated on at all.

After these changes there was a rest for a time; at least there were no signs of the activity of inventive minds. Mills were built embodying these principles and details, and, as the grinding was heavier, at the first reduction, the bran products were necessarily heavier. This suggested an additional reduction, and as the middlings remained unreduced after purification, additional reductions had to be supplied here. Thus the purifier added the bran cleaning reductions and the following reels, and one, two or more reductions for the middlings and the reels which separated this stock. Thus, even at this time, we had a species of gradual reduction. A year or two before the introduction of rolls another great change was made in the millstone dress. The eye of the buhr, as a portion of its grinding surface, was entirely removed. Most mills with four foot buhrs reduced the surface to nine inches of skirt with the usual slant toward the eye from a line two inches from the extreme of its circumference. Then we began to hear about rigid spindle mills; mills whose grinding surfaces were a fixed and controllable distance apart; mills so arranged that there could be no possible oscillation of the runner. This represented the perfection of the idea, though it was never realized on a large buhr.

As the grinding became higher and the products of middlings became larger, owing to the high grinding and the improvements in method, it became necessary to take measures to care for certain grades of stock other than middlings which were developed through the purifier, namely: germ, tailings and dustings. The smooth rolls took their place at this stage of the process and added to the machinery already used in the mill. Accompanying them, of course, were the reels, and as an offal from these reels, which the prudent miller did not care to run into his feed pile, there was the red-dog stock, which was taken care of by millstones and following reel or reels. In a mill which formerly contained only its millstones for the reduction of wheat and a reel or two for the separa-

tion of the flour there was added, consequent upon the introduction of the purifier, first, a buhr for cleaning the bran, one or two besides for the reduction of the middlings, two or three pairs of rolls for the reduction of the tailings, germ, dustings, etc., and finally a red-dog stone. Following each reduction there were the reels. The great change is here made apparent. The limit of possibilities in the production of middlings by the millstones was reached. The rigid spindle mill was the last step previous to the roller system. As we said, the idea of the rigid spindle mill was a reduction machine with its grinding surfaces a fixed and controllable distance apart. The rolls were the offshoot of this idea. In them were realized the desirable features of such a machine. Gradual reduction existed in new process milling by millstones as a necessity. The middlings, the bran and other products required additional reduction. Gradual reduction, as applied to the making of middlings by corrugated rolls in the roller process, was a principle as broad in its application to reduction as was the purifier in its original application to separations. Thus we have the purifier, not only as a revolutionizer of separations, but of reductions as well. We have the purifier, first, as a machine which took care of a product of old process milling, and which ultimately revolutionized it. Then we have the rolls and millstones forming a gradual reduction system to take care of the materials brought into existence by the purifier; and finally, we have this same gradual reduction method as a revolutionizing element in new process milling. Gradual reduction, while it was formerly applied only to the intermediate products following the original reduction of the wheat by the buhrs, with the rolls became part and parcel of what is now recognized as the gradual reduction system. With the introduction of this method we recognize different classifications requiring distinct reductions and as many separations. In later years this system of gradual reduction has been carried still farther, in the reduction from large to small middlings, in the reduction from middlings of such a size as still contain attached to or as part of them certain objectionable impurities, to a size which admits of the removal of certain portions of this material. This process of the gradual reduction of middlings is carried as far as the limits of their purification by the ordinary machines will allow. As following out and adding to the machinery of purification which has always been the path of progress in milling affairs, the smooth rolls have come to be regarded as part of the purification machinery, and, as such,

are legitimately regarded not only as reduction machines but as purifiers as well. This is the last step in the classification of the steps of milling progress. It is clear that the sole purpose of all changes in reduction methods since the introduction of the purifier has been with reference to increased production, in the first place, and increased purity in the second.

CHAPTER III.

THE UNDERLYING PRINCIPLES OF MILLING METHODS—THE PURPOSES OF WHEAT MILLING—WHEAT CLEANING AS A PURIFYING PROCESS—THE MIDDLINGS PURIFIER AS A BROKEN WHEAT CLEANER—THE REASON FOR THE PURIFICATON OF MIDDLINGS—REDUCTION FOR THE PURPOSE OF PURIFICATION—PURIFICATION FOR THE PURPOSE OF FURTHER REDUCTION—GRADUAL REDUCTION AND GRADUAL PURIFICATION OF MIDDLINGS.

In considering the various details of milling. I do not remember having noticed any attempt to show up the broad underlying principles ot milling as it is now carried on.

The purpose of milling wheat is to get it into such shape that it can be made into bread, the idea being to get the most money out of it, and the process of so doing is to make the most flour possible out of the wheat and of a quality which will make the most bread out of the flour. It so happens that the most bread can be made out of the purest flour, the purity of anything being always estimated with reference to its complete fitness for the purpose for which it is intended. A thing might be spoken of as pure for one purpose when it would be impure for another. The best bread is that which is best to eat, and the best flour is that which will make the best bread, and the most of it, out of a given quantity of wheat. Now, if pure flour makes the best bread, the means of making pure flour is the logical sequence in this consideration. It is a question of process and the machinery to bring about that process automatically and economically. As to the process, and as a part of the desired end, reduction is the first great step and separation the second. Purification is the controlling idea as to the quality of the product. Reduction is a necessity in order to get wheat into flour form, and the success of the purification is the value-giving element.

Where the cleaning of the wheat has to do with the removal of impurities which are a part of it, it belongs to the purifying process. If we could thoroughly purify wheat, if its impurities were all on the outside, we would never have had the middlings purifier in the first place,

or gradual reduction in the second, or bolting machinery either, only in so far as it was desirable to grade the reduced material—a necessity brought about by incomplete reduction. If such a thing could have been done, such machinery would have been entirely unnecessary, excepting as developed by incomplete reduction devices. The fact that there are particles of material scattered throughout the grain of wheat which are deleterious to the bread-making qualities of the flour, was what developed the necessity for the middlings purifier, as a purifier of broken wheat. It was for the purpose of purifying the wheat that the middlings purifier was invented, and it was for the purpose of making more stock which could be purified, that is, middlings, that the system of gradual reduction was arranged. In the sense that a middlings purifier is intended for broken wheat, it is desirable that a large proportion of the stock should be maintained in this form rather than in the finer particles known as flour. The reason that middlings can be purified and flour cannot, commercially, is clear when the principles of the purification of middlings are stated. The impurities in middlings are either larger in size, less in specific gravity, or different in structure from the desirable portion. In event of the impurities being larger, they may be separated from the middlings by bolting cloth. In event of their being of less specific gravity, air currents are arranged so that the lighter particles may be sent in one direction, while the middlings take their natural course in another.

The separation, according to difference of structure, is made by rolls. For instance, germ may be flattened, while the middlings will be broken, or a piece of bran may pass through smooth rolls intact, while the middlings, which are of the same size as the bran, would be broken into several pieces. By such an operation, the question of separation becomes merely one which has to do with the size of the impurities. The germ and bran thus being larger than the middlings with which they are mixed, are readily separated by bolting cloth, as before stated.

It is said that middlings are made in order to purify the wheat, and for the reason that the impurities thereof are not all external. It does not follow that the wheat can be purified by the mere reduction to middlings, and their treatment as such by the purifying agencies mentioned, but it does follow that the fracture of the wheat liberates certain of the contained impurities, and as there are impurities contained in the unreduced middlings themselves, which would get into the flour by the im-

mediate reduction of the middlings after their handling by the purifiers, it follows that the gradual reduction of the middlings is as necessary as is the gradual reduction of the wheat. As this gradual reduction continues, so does the purification. Gradual reduction and purification go hand in hand. It is gradual reduction *and* gradual purification. This is milling, and anything less complete is, in the same degree, incomplete milling.

There comes a point in the gradual reduction of wheat when we can no longer take off middlings of such a size as to commercially purify them. It then remains to take off all the flour remaining on the bran. In the process of making middlings, certain particles of the wheat and of the contained and other impurities are broken into such fine pieces that they cannot be treated by the purifying agencies outlined. It remains to handle such material on reels, taking out such a part as is known as flour, and making a separation of stock which may be designated as dust middlings, they being between middlings and flour. The purity of this stock may be very much enhanced by the action of the smooth rolls, which reduce the middlings or flour particles, and either flatten or do not disturb the impurities. In this sense the smooth rolls and the following reels are purifiers, in that they remove a portion of the impurities.

The same thing happens in the gradual reduction of middlings, though in that instance there is less effort to prevent the production of flour. But at the same time its production is gradual, in order that the middlings may be of such a size as to admit of purification and other reductions. Milling is a process of reduction and purification, and in order that the purification may be more perfect, the reduction and purification must be gradual. The reduction of the wheat has in view the production of middlings for purification. The gradual reduction of middlings has in view their gradual purification in order that it may be more complete. It is more complete by being more gradual, because there are contained impurities in the middlings which are liberated or detached with each reduction.

Which system of the gradual reduction of wheat is the best? That system which will make the most middlings, the least flour, and, ultimately, the cleanest bran. Which system of the gradual reduction of middlings is the best? The system which will break the middlings, and at the same time cause the least disturbance to the impurities, leaving them in a separable condition acccording to one of the three conditions previously named.

CHAPTER IV.

DEVELOPMENT OF SEPARATING MACHINERY—SYSTEM OF SEPARATIONS HAS CHANGED WITH THE SYSTEM OF REDUCTIONS—MECHANICAL IMPROVEMENTS IN BOLTING MACHINERY—THE CENTRIFUGAL REEL.

We are accustomed to think of the changes in milling as having particularly to do with the reductions and purifications by the purifiers. We are inclined to ignore the fact that changes in bolting and in all separations, independent of the purifiers, have been as great and as important as those having to do with the other methods.

It is true that up to two years or more ago very few changes were made in the machinery of bolting, but if we ignore the fact that such changes and improvements have been made in recent years, even then it is clear that in the advancement, the bolting arrangements have kept pace with other details of the mill. The fact that a change has been made independent of the improvements in the machinery of bolting in itself, suggests that such a change must be in the system and arrangement of parts.

As now arranged, the idea is not merely to separate the fine from the coarse stock in an abrupt way, but to make such separations according to principles and ideas which will not only remove the coarse particles of bran from the flour, but also the fibre and soft matter, material of the same size as the flour particles, and in fact remove to a greater extent than ever before, all of the impurities of the wheat, independent of their relation as to size to the flour and middlings particles.

In former times the miller ran his chop from the stones into their reels, and commenced taking off flour at once. Generally there were not more than two reels. Flour was taken off from both. The bran and flour stock which did not pass through with the flour stock of the upper reel would tail into the one next below. After all of the flour had been taken out, the middlings and shorts were removed and finally

the bran tailed off at the end of the bottom reel. Of course there were cases where there was a single reel, but the same general principle was carried out.

Now the miller will notice how great has been the change in the principle of separation. While in the instance just mentioned flour was taken off first, middlings and shorts next, and the bran tailed off at the last, the correct thing to do, according to present practice, is to exactly reverse this order of proceedings. First, remove the bran, then the middlings and then make the flour separations. It is clear that a change could be no more complete.

In the millstone mills operating under the new process idea the bran was first scalped out on a scalping reel; that is, this was done in the more complete and better arranged mills, and then the coarse middlings were removed, and before the final flour separations were made, the fine middlings were taken out.

In the case of the millstone separations, it is necessary that a certain portion of the fine middlings be retained in the reels in order to assist in bolting. But with the better class of mills as little of this sort of thing was done as was possible. A smaller proportion of middlings was retained for the sole purpose of preventing the reel from pasting or clogging. After the introduction of gradual reduction methods this principle was even more clearly marked than before, and developed into what is known as the scalping system, which applies not only to the scalping from one reduction to another, and the separation of the finer particles previous to the flour separations, but has to do with and is applied to the flour separations themselves.

This is illustrated when we remember the very common practice of putting scalping cloths on the tail of nearly all flour reels, which is done with the idea of separating the impurities from the flour stock at every opportunity, of reducing the proportion of such impurities which may continue through the course of the mill. It is only the very fine middlings which will pass through an 8 or 9 cloth that are allowed to pass through the flour reels.

There is a much smaller proportion of flour stock with the reduced material than in former years by the millstone method, and, at the same time, there is a smaller proportion of fine flour, for which reasons there is less difficulty in bolting this stock and less reason for running middlings with the flour.

The fact that there are many mills which are not doing their bolting according to these principles does not disturb the theory of the general improvement and general change in the bolting system. It merely indicates that the owners of such mills are not living up to their opportunities.

As apart from the changes in the system and arrangement of bolting machinery, there have been changes in the machinery itself. In the first place may be considered the changes in the construction of the ordinary reel. As now designed they look entirely different from the machines of earlier times. Not only do they look different but they are different, and the changes have been not merely those of convenience to the miller, but of radical improvement in the character of the work which they will do. There are the improved feeding arrangements, the speck boxes or heads, improved tail boards, the double conveyors, arrangements for examining the stock as it passes from one reel to another, and finally the arrangement of the conveyors side by side which makes it possible for the miller to examine his flour one slide at a time when it becomes necessary, and to do it with the utmost ease. Thus he can determine to a nicety just how much flour can be taken from the reel. There is no guess work—no estimate to be made of the general result by the general appearance of the flour as it comes from the conveyor.

The centrifugal reel when introduced into this country, was hailed as something which would create a revolution, but it had none of the radical elements in its principle. It was said that it would supersede all other bolting arrangements, but it did not and cannot do it. The introduction of this reel was merely an addition to the good things which we already had, and as such an addition, was an improvement. The proof of this is to be found in the fact that even those who had the completest mil s, and added these centrifugal reels, did not find it possible to do away with any of the other bolting machinery of their mills. As said before, they had added the machinery to that they already had. Many of them took the flour which they had already made and re-bolted it on the centrifugals; others prepared stock on the centrifugals to be re-bolted on the common reels. One thing which a centrifugal reel can do is to correct some of the evils of a too close reduction by smooth rolls. Again, a centrifugal reel will re-bolt flour or fine stock which could not

be handled by ordinary arrangements. In this fact alone is its principal merit and determines its greatest usefulness.

The Morse elevator bolt occupies a field, mechanically, of its own, though as a milling machine to all intents and purposes it belongs to the same category as the centrifugal.

The Jonathan Mills reel promises well, but cannot be considered at this time because of its recent introduction.

CHAPTER V.

THE DEVELOPMENT OF ROLLER MACHINERY—THE EARLY SMOOTH ROLLS —THE IMPROVEMENTS IN ROLLER MACHINERY—THE SIZES OF ROLLS MADE BY VARIOUS MANUFACTURERS.

The first use to which rolls were put in this country was to the crushing of wheat.

This crushing of the wheat was favored and practiced by many millers. As to how much good was accomplished by such an operation was never fully determined. It certainly did no harm. The bran was not disturbed or broken to a damaging extent, nor was the form of the wheat changed in such a manner as to operate unfavorably upon it during the course of its reduction by millstones.

These rolls were very clumsy contrivances; many of them were as large as eighteen inches in diameter, and from thirty-six to forty inches in length, and the adjustments were frequently made by a monkey-wrench only. The rolls themselves were of ordinary cast iron, not chilled. After being run for a time they became pitted and irregular and uneven in form. Very early in the history of this process granite, stone and marble were used.

After a time, however, smooth rolls came into use for the purpose of making a germ separation. These were chilled iron rolls. After this such rolls were used for making wheat reductions in the manner above described, and the stone and cast-iron rolls were discarded. The mechanical arrangement of these chilled iron rolls, as first used, was about as clumsy and ordinary as could be devised. The process of leveling them or keeping them in line with each other was a matter of great difficulty. It was usually done by adjusting them and then running the boxes to suit. Then these boxes were difficult to lubricate, and as for keeping the frames clean, that was out of the question.

The frames were usually of wood, heavy and ponderous. Arrangements for adjusting were primitive indeed. There was the hand-wheel of the ordinary form without spring or tension attachment, and between the two boxes, on either side, was a round stick with a piece of rubber

on each end which was intended to throw the rolls apart when the hand-wheel compression was released. When the belt happened to pull in the wrong direction the rolls never could be open at both ends.

The arrangements for inspecting the stock which passed through these rolls clearly indicated that it was rarely done. In the first place the rolls sat too close to the floor, and then the opening was nothing more than a round hand-hole in the hopper under the frame, and when opened would cause the flour to drop to the floor. A large number of such machines were in use during the whole period of new process millstone milling. During the latter part of this period, however, other more suitable and better contrived arrangements of rolls were put into use. For the most part they were cast-iron frames arranged for a single pair of rolls, with journal-boxes of brass and babbitt linings—a more intelligent construction than those of the earlier period. Arrangements for adjusting were a little better than the ordinary arrangements. In truth, at this time very little attention was usually paid to the adjustment of rolls. When the mill started they were set up tight, and when it was stopped they were opened out, one end at a time, with the hand-wheel. It was not an unusual thing to see a pair of rolls set up by grasping the hand-wheel with a monkey-wrench so as to get a good purchase on it. Of course the stock which passed through such rolls was mostly flakes, and in order to get rid of these flakes it was run through a bran duster, which destroyed all the purifying effect of a roller reduction. This condition of things was quite common after rolls came to be used for other purposes than germ reductions. For instance, on dustings, returns, etc.

The great change in roller machines was made immediately upon the introduction of corrugated rolls for reducing the wheat. These changes were made by the suggestions offered by the imported rolls. They were of very superior construction. Our people were quick to recognize the necessity for more perfect arrangements, as gradual reduction made it imperative. Prompted by the example set us by our foreign neighbors, our mill builders immediately set about to give the millers a better roller machine, and to-day the American miller certainly has the most convenient and ingenious arrangement of roller reduction machines to be found anywhere in the milling world. As to excellence of workmanship they are certainly equal to the demand.

From rolls of thirty and thirty-six inches in length and ten and twelve inches in diameter, a change was made immediately after the time of the

changes in reduction methods to eighteen inches in length and nine inches in diameter. Now we have machines that are much smaller in every way, for the purpose of adjusting the size to the requirements of small mills. However, 9x18 more nearly approaches the standard size than anything else that can be called to mind Twenty-four-inch rolls are still used, but thirty-inch machines are not recommended by the best or most successful mill builders.

The belt drive was one of the innovations and was received with approval by most of the millers of this country. All, however, did not use the countershaft device for driving the slow roll, substituting instead a cross belt connection with the main line shaft.

While a single pair of rolls was the common number for a frame, according to the earlier practice, two pairs of rolls to a frame has been the common and almost universal custom during the recent years. It has not only been more economical, but is more convenient as well. It makes possible a more perfect mechanical contrivance for driving and adjusting.

Other details of arrangements and improvements which have been made upon roller machines are well understood, and as far as the writer knows there is not a roller machine on the market which will not do good work if intelligently handled. There are little differences of detail and small conveniences which may make one roll or another a favorite with various millers, but there are no roller machines that are not well adapted to doing good work under judicious management.

The following are the sizes of rolls made by various manufacturers. Under this head is included both smooth and corrugated:

EDW. P. ALLIS & CO., MILWAUKEE, WIS.

Gray's Noiseless Belt Roller Mill.—Standard style, 4-roll, 9x14, 9x18, 9x24 and 9x30 inches; standard style, 4-roll, with Wegmann's patent porcelain rolls, 9x14, 9x18 and 14x16 inches; style B, 4-roll, with smooth chilled iron rolls, 9x8, 9x11 and 9x14 inches; style C, 9x8, 9x11, 9x14, 9x18, 9x24 and 9x30 inches. Four-break reduction machine, No. 1, 6x6 and 6x8 inches; No. 2, 9x8 and 9x12 inches. Double or 4-roll machines, 6x12, 6x16 and 6x20 inches.

STILWELL & BIERCE MANUFACTURING CO., DAYTON, O.

Odell's Patent Noiseless Roller Mill.—Standard style, double and single, 9x18, 9x24 and 9x30 inches, also 10x24 and 10x30 inches in ex-

tra heavy frames; style C, 4-roll, 7x14, 7x16, 7x18 and 7x20 inches; quadruple, 8-roll, 7x14, 7x16 and 7x18 inches; style D, 4-roll, 7x14 inches; concentrated mills, 2, 3, 4, 5 and 6 breaks, 9x18, 9x24 and 9x30 inches.

THE JOHN T. NOYE MANUFACTURING CO., BUFFALO, N. Y.

Stevens Roller Mill.—Single, 6x12, 6x15, 6x20, 9x15, 9x18, 9x24 and 9x30 inches; double, 6x12, 6x15, 6x20, 9x15, 9x18, 9x24 and 9x30 inches.

Cosgrove Concentrated Roller Mill.—Five-break machines, 9x15, 9x18, 9x24 and 9x30 inches.

Rounds Sectional Roller Mill.—Two, three or four breaks, with cylinder scalpers, 9x24 and 9x30 inches; also same without scalpers.

STOUT, MILLS & TEMPLE, DAYTON, O.

Livingston Belted Roller Mill.—Double or single mills, 9x12, 9x15, 9x18, 9x24 and 9x30 inches.

Gilbert Combination Mill.—Four or six-break mills, 9x12, 9x15, 9x18, 9x24 and 9x30 inches.

Eight-Roller Universal Mill.—6x9, 6x12, 6x15 and 6x18 inches. Also 4-roller mills same sizes.

NORDYKE & MARMON CO., INDIANAPOLIS, IND.

Size of Rolls.—Single, 9x18, 9x24 and 9x30 inches; double, 6x12, 7x14, 7x18, 9x18, 9x24 and 9x30 inches.

CASE MANUFACTURING CO., COLUMBUS, O.

Bismarck Roller Mill.—6x12, 6x18, 9x18, 9x24 and 9x30.

GRISCOM & CO. & M'FEELY, PHILADELPHIA, PA.

Butler Roller Mills.—9x18, 6x12, 6x16 and 6x20 inches.

BARNARD & LEAS MANUFACTURING CO., MOLINE, ILL.

Daverio Three-High Roller Mill.—6x12, 6x15, 9x18 and 9x24 inches.

TODDS & STANLEY MILL FURNISHING CO., ST. LOUIS, MO.

Four-Roller Mill.—7x14 and 9x18 inches.

JOHN JAMES & CO., LA CROSSE, WIS.

La Crosse Smooth Chilled Iron Roller Mill.—Single, 5x10, 6x12, 6x15, 6x18, 9x12, 7x16 and 9x18 inches; double, 5x10, 6x12, 6x15 and 6x18 inches.

DOWNTON MANUFACTURING CO., ST. LOUIS, MO.

Cranson-Dawson Patent Roller Mill.—Single, 9x18, 9x24 and 9x30 inches; double, 9x18, 9x24 and 9x30 inches.

W. H. BARBER & CO., ALLENTOWN, PA.

A. N. Wolf Patent Noiseless Roller Mill.—Two-roller, 4-roller and 8-roller mills, 7x14 and 9x18 inches.

ELI STRONG, KALAMAZOO, MICH.

Strong Patent Roller Mill.—9x18, 9x24, 7x12, 7x15 and 7x18 inches.

FARMER ROLLER MILL CO., GRAND RAPIDS, MICH.

Fox Patent Roller Mill.—Single, 6x12, 6x16 and 6x20 inches; double, 6x12, 6x16 and 6x20 inches.

PHŒNIX IRON WORKS CO., MINNEAPOLIS, MINN.

Monitor Roller Mill.—No. 2, 6x12; No. 3, 6x15; No. 4, 6x18 inches.

Little Monitor.—No. 2, 6x10; No. 3, 6x12 inches.

RICKERSON ROLLER MILL CO., GRAND RAPIDS, MICH.

Rickerson Patent Noiseless Roller Mill.—6x12, 6x15, 6x18 and 6x20 inches.

NORTH STAR IRON WORKS CO., MINNEAPOLIS, MINN.

Fir Roller Mill.—Double, 9x18 inches.

WILLFORD & NORTHWAY MANUFACTURING CO., MINNEAPOLIS, MINN.

Noiseless Belt Roller Mill.—Single, 6x12, 6x15 and 6x20 inches; double, 6x12, 6x15, 6x20, 9x14, 9x18 and 9x24 inches.

CHAPTER VI

DEVELOPMENT OF MACHINERY FOR SMALL MILLS—THE COMBINATION MILLS—PRINCIPLE OF THEIR CONSTRUCTION—SUGGESTIONS AS TO CHANGES—CONSOLIDATION A NECESSITY IN SMALL MILLS—THE DISC MILL AND ITS DEVELOPMENT.

After the large mills got their start, the small millers began to look around to see what they should do to keep up with the improvements, the expense of such mills being one element in the problem which received serious attention. The first thing done was to build a roll frame with a scalping reel immediately under it. Most of this frame was of wood, and the reel was a little over two feet long. A millwright, on being asked if he did not think that this was too short, said no, that if the stock was not well dusted when it went to the next reduction, that coarser cloth could be put on the reel. A certain local millwright was quite enthusiastic about this machine, and honestly so. He had a plan in which he proposed to get a four-break mill in on two floors without the use of elevators to carry the stock from one scalper to another, his idea being to build a platform on each floor and in that way have the rolls placed on four different levels. Thus the first break rolls, which would be on the platform located on the second floor would tail off to the second break rolls immediately below this platform on the floor proper, and from that to the third break located on a platform on the first floor, then to the finishing rolls which were immediately under. The product of the scalping reels he intended to run to an elevator. This thing was probably never done, but was the germ idea of the combined roller mill which followed.

The combined roller mill, the one which combines rolls and scalpers all in one frame and driven by the same belt, was the most promising of the steps made in the direction of the decrease of the expense of building small mills. The first combined mill was the one with brush scalpers, and was launched forth with a good deal of enthusiasm, and not without reason, for it has since met with a degree of success. If memory is not at fault, this mill was first operated at Faribault, Minn.

In any event, it was in one of these towns connected with the early history of the purifier. An article appeared in a local paper in which the enthusiasm and zeal of the writer would have the public believe that this invention was on a par with the purifier, and exhibited a good deal of pride that two such machines should have emanated from the same town. There will be occasion to refer to this machine again, for whereas it was the first machine put on the market, it is still one of the best. Other combination machines followed, in just what connection is not known, but there was one in an iron frame which had scalping reels of the ordinary type following each pair of rolls. The frame was built in sections containing one reduction each, and by placing one section on top of another any number of reductions desired could be had. This machine never came into very general use, but some of them were sold and are still operating.

A combination machine which came out about this time had sieve scalpers of peculiar construction. This, too, met with a moderate degree of success. One thing about this machine was that it was not too high, it being possible to get a six-break mill all on one floor. These combination machines rarely have more than five breaks, however.

The Seck combination mill was probably brought to this country before either of the two latter machines were in operation. It is not known to the writer that it ever passed beyond the experimental stage, though it was very favorably reported on from Minneapolis. This machine contained a very ingenious device for conveying the stock from the roll discharge to the reel, both of which were on the same level.

One of the most novel arrangements for gradual reduction for small mills is a device which makes three or four breaks with one pair of rolls, which are divided into sections for the various breaks, each section varying in length, diameter and fineness of corrugation. The increase in diameter, section by section, makes it possible to gradually come down on the stock as the reductions progress. For instance, the section which accomplishes the first break is the smallest, hence the grinding surfaces are farther apart. The next section is a little larger, and so on to the finish. There are short elevators for transferring the unreduced material from one section to another.

One of the latest combination machines is for four breaks. The rolls are all on one level and are inclosed within one frame, which is of wood, the pairs of rolls being so placed that one pair comes at each corner of

the frame. The scalpers are immediately under the rolls. They tail toward the middle of the frame, where room is left for elevators which carry stock from the tail of one reel to the hopper of the next roller reduction. This machine occupies less space in height than any of the others, unless it be the last mentioned, but more floor space, which, however, is not great. This is a complete belt drive machine.

In the opinion of the writer there is one fault common to all combination machines, and that is the unvarying length of the scalpers. A scalper which is long enough for the last break is too long for the first ones, or if it is the proper length for the first breaks it is too short for the last. We all know that it is absolutely necessary, in order to carry out the principles of gradual reduction, that all of the flour and middlings made on one reduction should be taken out before it passes to the next. It is also a matter of knowledge that the scalpers should not be too long, that the stock should not be whipped around in a reel when there is nothing in it which can be properly taken out, but which, in the nature of things, will cause a dangerous proportion of small red bran stock to be run into the reel product of better material. This, however, is hardly a fault of the scalpers of the combination machines. They are more often too short than too long on all breaks except, perhaps, the first and second. The first combination machine made got over this difficulty better than any of the others by using brush scalpers, that is, scalpers with brushes on the inside. Brushes, however, do not seem to be exactly the thing for a scalper, as the tendency is to pulverize the stock. One way to get out of the difficulty of properly scalping the stock on the middle and last breaks is by using centrifugal scalpers, though they are not so good as the common reels of the proper length.

A combination mill might be made which would obviate all of the difficulties mentioned. With the first and second breaks, is suggested the use of the reels as ordinarily made. When it comes to the third break a centrifugal might be used, but of a type not so severe as those in ordinary use, being as mild in its performance as possible to keep the cloth open. The fourth break scalper would be a centrifugal of a more pronounced severity in its movement and beater qualities. The fifth, if it be the last break, should be of the ordinary centrifugal type, which would give a clean tail over the tail of the reel. By such an arrangement there would be scalpers of an uniform length, say four or five feet,

but of increasing severity from the first to the last breaks. This is all that is wanted to make a combination machine a success. It is the lack of such an arrangement which has caused trouble in times past.

Smooth rolls of short length and small diameter are now being made for small mills. The time was when a small miller had to buy the same sized smooth roll which was ordinarily used in large mills, and if he did not have the proper quantity of stock to run on this roll of a particular class, he ran other stock to it to make up the volume. Regular practice of this kind developed a habit, early in the days of gradual reduction milling, which leaves its mark on the mills of to-day. That habit was to run conglomerates on the rolls. By this is meant stock of different kinds, fine and coarse, bran and white stock. It is as difficult to reduce fine and coarse stock together on the same roll as it can be to do anything which was never done before. The introduction of smooth rolls of small size opens a way for a change in the old habits. There are smooth rolls which are arranged immediately over a reel frame, that is the roll and reel are together and form a combination machine. It must certainly be a very agreeable arrangement for many mills, saving expense in that it dispenses with an elevator quite often, but more than all consolidates the machinery. The millers of these small mills have so much more to do than they can do to the best advantage, that it is pleasing to notice any changes of this kind which will lighten their burdens. In the old days of stone milling when a miller had one or two pairs of buhrs, perhaps, and one or two reels and the cleaning machinery to take care of, it was possible for him to devote attention to the customers; to help unload and weigh the wheat; to do all of the sweeping and take care of the mill, without doing himself an injustice. But since that time there has been a constant addition to the machinery which requires constant and increasing care and attention from the miller without a corresponding diminution of the amount of outside work required of him.

Anything which leads to a consolidation, to a drawing together and simplification of milling machinery, is to be looked upon as a positive improvement in milling methods. Not but that as good work can be done without the combination, but that the work will be better done where there is such an arrangement. Where there is scattered machinery which extends over two or three floors and with a wide distribution on each, and taken in connection with the fact that the miller has so much irreg-

ular work to do which divides his time and attention, he cannot get good work—uniform work—out of his mill. If the machinery arranged in combination form were even not so good for milling purposes, the results would be better on account of the care and attention which it might receive by the lightening of the labor.

There seems to be no way of solving the problem of gradual reduction for small mills except through the means of combinations and consolidations. Combination mills are not as popular as the other arrangements, because of prejudice built up against them on account of the lack of complete success of combination break mills, but the way has been pointed out in which this difficulty will be eventually met.

Disc mills, which do good service on the first break, have been largely made and marketed for small mills. One great reason why they have not been generally used has been on account of what was supposed to be the mechanical troubles attending their operation. They were always getting out of adjustment, getting hot in the neck and otherwise causing trouble. At the same time that this was so, there are few pieces of machinery which have been put into a mill which were more carefully designed or better made. The whole trouble has been owing to the extravagant claims of capacity made by their designers. This is particularly true where these machines have been put into large mills, and because there was not so much for them to do, has been the cause of their greater popularity in such mills. Take, as an example, a prominent disc reduction machine. Somebody was anxious to build large mills with a small amount of machinery. We all remember how hot the chop came from these mills on the middle and last breaks. There was no reason for this other than overcrowding. A disc mill for the size spoken of does not rightly or naturally have any more capacity than a single pair of 9x30 rolls, but the fact is that anywhere from three to five times as much stock was forced through them by high speed. Experience with a millstone led to the belief that a high speed and a heavy feed were two things which we did not want, yet after arriving at the perfection of millstone work by slow speed and a light feed, the disc mill was devised and we went to the other extreme of over-grinding, overcrowding. A disc mill is nothing more or less than the perfection of the millstone idea. It is the degradation of the millstone idea to take a perfect machine and kill it by overwork.

CHAPTER VII.

INVESTMENTS IN MILLS—THE PRODUCTION OF CHEAP FLOUR—OVERRATED MILLING CAPACITY—A SYSTEM OF MILLING WHICH MAKES MONEY.

Capitalists sometimes hesitate to invest money in mills because of the past uncertainty of milling affairs as applied to systems of manufacture. It is only within the past year that the majority of millers would believe in a stable condition of things.

At this time there is less interest of an excitable nature, less interest brought about by uncertainty in milling affairs than formerly. Most millers understand well the work which they have in hand; understand what they are doing at present, and, what is more interesting, feel assured that the doings of the future cannot be widely different from the work of the present. The knowledge that it was possible to purify middlings brought about more than ten years of hard work, and completely revolutionized the system of milling. It has taken these ten years or more to work out the details of a system which had its root in the idea of a purifier. This time of which we speak has been wholly taken up with the idea of purification. The work may have apparently diverged from that point, but there has always been a clear connecting line, no matter how great the divergence. The purifier improved the millstone work. Its efforts were to get the most middlings by means of the millstone. The purifier discarded the millstone and supplanted it with the roller system of gradual reduction, and it will favor any system or any detail which will make more or better middlings than any other system or detail. The matter of purification controls the introduction of new machinery. It will decide whether or not the roller system of gradual reduction will keep its place. The indications are that the minds of people have settled down to the fact that there is nothing better in sight for making middlings than the system now in use. This is a general and common feeling among millers and men engaged in manufacturing milling machinery. It is a feeling which is opposed to the restlessness of times past. It has had its quieting effect upon the present, as it will continue to have in the future. The fact that there has been no

reduction machinery which has been decidedly successful when compared with the rolls, is another thing that will serve to enforce an easier feeling on this subject. After the system of gradual reduction by rolls was established, there were continuous and strong efforts to supplant it by other means. This was the result of the impetus which the inventive spirit had received in the past. It had been set in motion, and it was difficult to stop, even after the goal had been reached. It was sliding past the station.

Investing money in a mill is like investing it in rental property. Say one has eight or ten thousand dollars to invest, and he puts it in houses —small houses. Now, one man will make them as cheap as possible. They will be mere shells, barely keeping out the rain, but not the cold to any great extent. Another man builds about the same sized house, builds it reasonably well, adds a few of the conveniences to the interior, and altogether has a building which is quite habitable and somewhat attractive. Now, there would be times when the man who has the cheap house would get a larger return on his investment than he who has been somewhat attentive to the comfort of his tenants. But as soon as there comes about a little stringency in business matters, and there are vacant houses, the man with the very cheap house will be the first to suffer, while he who has done something better will retain his tenants upon a profitable basis. His houses will be among the last to be empty—in fact, as long as houses are rented at all, he will have his income.

It is just so with milling matters. There are times when any kind of a mill will make money. There have been such times. But again there comes a change when only the fittest are known to prosper. In times of prosperity one miller has been known to say that he did not think it necessary to fill his mill full of machinery to make a little flour; that he was doing about as well as his neighbor, with two-thirds of the investment. But when the commercial pinch is felt, the man with the two-thirds mill growls dreadfully, and says there is no money in milling. He cannot understand why his neighbor keeps moving along. He figures out a loss of twenty-five cents a barrel on every barrel of flour he is making. But the neighbor still moves along. He runs full six days and a half in the week, and it is known that he has orders four and six weeks ahead. But the two-thirds man does not understand it—says milling is not what it used to be, and he recalls and lives on the time when he made a dollar a barrel. The fact is, he is neither making his flour so good nor

so cheap as the miller who is more prosperous. He has neither the machinery nor the mill with which to do it.

There are in mind at this time several instances of the kind which I here mention. One mill, in particular, is recalled, which has three times as much machinery to make a given quantity of flour as is being used in many other mills. It is known that this miller is getting, on an average, a dollar a barrel more for his patent flour than the regular market quotation on this grade. This does not indicate the exact difference in his receipts for the same quality of flour as compared with that of some other millers, as he is making his flour cheaper, that is, using less stock than is common with the majority of millers. He is not only making his flour better, but is making it cheaper. He is cutting profits on both ends of the string. Now, how does he do it? In the first place, he cleans his wheat, and he does it slowly. He does not operate on the full advertised capacity of the machines for a twenty-four hour run, and then do all the work in twelve hours. He runs his cleaning machines below what would be considered the ordinary rating of capacity, and, as he has not enough machinery to clean his wheat in a few hours, he keeps it going all the time, and he has enough help so that it can be properly watched—watched not only as to the quality of the work done, but as to the waste in cleaning his wheat.

Now, we all know of instances where the miller who has wheat to clean, periodically starts his cleaning machinery, runs it two or three hours and fills up his bins. In many such instances the machines have one-half to one-third more work to do than their advertised capacity, which latter is more than they are capable of doing to the best advantage. In the cry for machines of large capacity, the makers have been forced to advertise the maximum amount which can be done by their machines; hence, when they are crowded beyond this point, it is disastrous to good milling. Let him who reads this look about him and think how few very good mills there are into which he can go and take a handful of cleaned wheat out of the first reduction hoppers. And while he is casting his eye around among his neighbors' mills, let him think of his own mill, that he may judge of the quality of the wheat cleaning there.

It was said that this miller who is doing so well cleans his wheat. This being done, he reduces it, and reduces it properly. None of the machinery is overcrowded. He has from a fourth to a half more grind-

ing capacity than is common in nine mills in ten. Thus he is able to make round middlings, and a small proportion of break flour. The middlings are such as can be readily pulverized. The flour is such as contains a small proportion of pulverized bran. He does only at each reduction what properly belongs to that reduction. It is not a struggle to make the rolls take the stock, but an intelligent effort to have them take what they can and do it well. He has seven breaks on the wheat, and he has clean bran when he gets through. There is very little flour to be dusted from his middlings, hence they are well dusted. There is a small proportion of middlings with adhering portions of bran, therefore they can be readily purified. These middlings are not simply cleaned on the machines and made to look bright, and reduced at once into flour, but, after being purified the first time, they are reduced lightly on smooth rolls. Flour is then taken out of them, and, by the way, this flour is of most excellent quality. Then the remaining middlings are purified again, and so on through a course of some seven or eight reductions, dustings and intermediate purifications. After the stock becomes too fine for purification on the machines, it is reduced on smooth rolls.

This is a system which includes the gradual reduction of wheat and the gradual reduction and intermediate purification of the middlings. The gradual reduction of the wheat is not gradual alone in that it is done by a succession of operations, but gradual in that as little as possible is done at each operation. This is the idea of gradual reduction milling. There are those who would call it fancy milling, and again there are those who would say, if this thing were not in actual practice, that this kind of talk might be all well enough in theory, but it would not make money. The fact is that it does make money, and that the miller who handles his wheat in this way is getting more money per bushel out of it than any other miller in the country, as far as the writer knows. He is probably getting more profit per bushel of wheat from his milling than any one else in this country. The means which are used to do this thing the writer cannot but think are the best means. The miller who gets the most money out of the wheat is the best miller, and the method which he uses to do this thing is the best method. There is no way of getting around this statement.

It is refreshing to know that no one can say of this miller that he is a mere theorizer—that he spends all of his money on his mill and that he has nothing to show for his investment. He is a money-maker, an accumulator, an enthusiast in milling work, a practical man and an extremist in all that he does. So far, his extreme methods have led him in the direction of extreme success.

CHAPTER VIII.

TROUBLES IN THE BAKING OF FLOUR—UNIFORMITY OF FLOUR COMPARED WITH UNIFORMITY IN ITS BAKING—THE DIFFICULTIES IN THE WAY OF THE UNIFORMITY OF FLOUR MANUFACTURE—CHANGES IN MILLS—THE EFFECT OF SUCH CHANGES IN THE MARKETING OF THE FLOUR.

It has happened many times that the housewife, when taking the first baking of flour from the new barrel which has just arrived, would look on it with suspicion, as she does on all new things in general, and new flour in particular. As she is suspicious, she is inclined to find fault, and, if we look down into her thoughts, we find that she does not think that this flour looks quite as good as the last, and that it does not act the same, thus fortifying herself with an "I thought so" as an equivalent to "I told you so," in event of failure. This is a splendid state of mind out of which to get a failure. It is anticipated. In many cases it so happens that the bread is not up to the family standard, and with the tale of woe she wends her way to the diplomatic miller, who induces her to try another baking, which frequently brings about a happier state of affairs, and after the third or fourth baking all troubles are forgotten. There is a story of a very good old lady, who prided herself on being a good judge of flour by the mere handling of it. Said she, "You just take a handful of it and throw it up against the wall and if it sticks, or if it don't stick, I forget which, why it's good flour." All this is very satisfactory.

Did it ever occur to the reader how much more uniform in quality is the flour than the bread which is made from it? If it were possible to view all the bakings of the average housewife from a single barrel of flour, the result would be appalling from a bread-making standpoint. Several times in my experience do I remember that I was in fear that lifelong friendships would be ruptured because a complainant felt so aggrieved over the fact that the last part of a barrel of flour was inferior to the other part.

Considering the methods of the manufacture of flour, its intricacies, the delicacy of its demands, the imperativeness as to the results, we

have reason to congratulate ourselves upon the general uniformity of the product. With all these things to be considered, I have in mind a milling firm which was ever ready to pay rebates and to make good all damages, and who did not have occasion, in a year's business, where over 200,000 barrels of flour were made, to meet any such demands. There are very few lines of manufacturing where the real difficulties of maintaining uniformity are so great, and, at the same time, there are very few lines where there is such exactness. In the mill there is a great deal done which no one sees. There is a constant moving on, a constant manufacture for better or for worse. Literally and figuratively, a great deal is done in the dark. One thing must be examined at a time. There is no place where the work, as a whole, may be taken into account, as may so readily be done in most other work. There are no opportunities for testing the work as a whole in a way to know that every thing is right at the moment. There is very little chance of forseeing difficulties or wrongs. More often than otherwise, changes in the operation of the mill—in its grinding, in its bolting or its purifying—are not made until the necessity is apparent from the result. There are no "cut-and-try" methods, there are no patterns or templets, fixed methods or arbitrary rules. A mistake once made is made forever. It goes on through the mill. If a carpenter gets a board too long he cuts it off at his leisure. If a miller gets his bolting too long, he cuts it off, but with the knowledge that something has gone before which was not as it should be—a mistake which cannot be corrected. With a miller a mistake cannot be corrected until it is apparent and more or less damage has been done. By the result he judges as to the necessity for a change. The result which has gone before he cannot change. If a millwright gets anything wrong it is always possible to make such alterations as will not affect the other parts of his work or the general result. It is required of a miller that he be able to judge with the utmost accuracy, to make close and fine distinctions as to the various results in the process of working out in the different parts of the mill. Thus his mind is trained in such a way as to recognize what appeared to him to be broad differences, while in fact, to the public, they are not noticeable.

In making mechanical changes, either in principle or in detail, it often and generally happens that the grades of flour are changed, say improved. The patent may be better than before, and we will allow that the same may be true of the bakers' or clear flour. The low grade may be worked

down in quantity. It may be said that the product of the mill is improved. All this may be so and the miller not be benefited in the least. On the contrary, when he makes such changes and brings about such results, the chances are favorable to his being hurt if he does not handle his trade very skillfully. The trouble, if any, generally comes about in this way. It will be allowed that previous to the time of making these alterations he had a trade for his flour under brands owned by himself or the trade, and at prices which fairly represented its value. Now the trade had the flour where that particular quality and price was wanted, and the general state of affairs, with them, was fairly satisfactory. The miller, desiring to get more money out of his wheat, improves his flour in the manner previously indicated. Realizing, as he does, that it is better than before, he wants more money for it. In truth, it is worth more, and he asks it from his buyers—they of the East and South. While they are willing to acknowledge that the flour is better, and that it is actually worth more money, the fact remains that they have built up the trade on the other grade—another flour. That whereas the flour was sold for $6 before, it is now a $6.50 flour in quality. But the $6.50 flour is not what the trade wants; they want a $6 flour, quality and price, for a $6 trade. When the grade is improved and the price raised, the flour has to go into new hands. The same jobbers may take it, but they have to put it into other hands. They have to build a new trade for a new flour, whether it comes from the same mill or another one. What if this jobber does say to his trade, which buys it in small lots from him, "This flour has improved; it is worth 25 cents a barrel more than it was before." And what if his buyer recognizes this as being so? He will say: "I do not want it improved; it fills the place which I have for it, and at its price." All he wants is the uniform grade. He has, maybe, a $6.50 grade from another mill under an established brand, which is altogether satisfactory, and he is not going to change to another flour, fearing, as he does, that the grade may be changed again; and he is justified in this view of the case. Consequently the trade for the old grade of flour is lost and has to be built up, and maybe at a time of the year when this is not easy to do. The illustration here given represents a state of affairs which is not at all uncommon. Now, while the moral of all this is not that one should refrain from improving his milling, it does suggest that it should be done understandingly, and with a view of meeting the dangers here referred to. A miller in Ohio who,

while he has been improving his milling from time to time, has not materially changed his grades since he adopted the gradual reduction system. His improvements consist in that he has gotten more flour out of the wheat, and has so separated it that the percentage of the lower grades has constantly decreased. But at the same time the quality has been approximately the same. This may not be the best way, but it is one good way. At any rate it is making money to-day.

CHAPTER IX.

THE EFFECT OF MILLERS CHANGING PLACES—CHANGES AND ALTERATIONS CAUSED THEREBY—THE EFFECT OF DIFFERENT MANAGEMENT OF THE SAME MILLS—THE CHANGES WHICH ARE TO BE MADE—THE TIME OF MONOPOLY AND HIGH GRADES PAST—CHEAP FLOUR THE FLOUR OF THE FUTURE.

It is not an unusual thing for millers to change places. There are many reasons leading to this. Naturally enough it frequently happens because of the desire to do better. The mill owner, in some instances, may think it to his advantage to dispense with one man's services and employ another. Maybe he has had an old and trusted miller in his employ for a long time, under whose administration the mill has always kept pace with that of his neighbors, and altogether has done good work and very good service. But some little thing, perhaps a personal matter, may cause a rupture which dissolves the business relations. We all know that such things do happen, and, when they do, the mill owner begins to cast around for another miller, and if it is a head or boss miller who is wanted, he considers the reputation of the various men within the circle of his acquaintance. He finally settles on one, and the negotiations are closed. Of course it is flattery to be called upon or to be selected from a number of applicants to take such a position, when the question of merit and reputation has been considered. At the same time it is a dangerous thing to make a change—dangerous to the miller and mill owner alike. As said before, the miller was selected because he had been doing good work. Of course he is anxious to preserve his good reputation, and while the mill to which he comes may have been doing equally as well as he was able to do, he is inclined to look upon it with suspicion. He looks around quietly at first, does not have much to say in the way of opinions, but his mind is constantly recurring to his last position and the way he did things there, and while the ultimate result is all right, the means or details do not strike him pleasantly. In the course of time he suggests one little change or another, and explains it so clearly or rationally that the owner is im-

pressed with the benefits which may be derived from it, and allows it to be done. When he asks how it is doing after this change has been brought about, his miller, whose mind is filled with hope, does not allow himsel to be disappointed, and he so explains it to others interested and with the honest belief that he has done a good thing. This makes it easier to bring about other changes and alterations with the idea, not expressed or perhaps realized in the mind of the miller, to have the mill like the one he had left. If the conditions were all the same, if the machinery were the same, this thing might be accomplished without harm; but here is a mill representing another man's ideas, which the miller now in charge wishes, with good intentions, to make accord with his own. But he does not do it at once; he does it gradually. It would be better if he intended to do it all, to bring about the change all at once. But this gradual mixture with the methods of his predecessor means nothing more or less than a constant series of experiments, some of which are almost sure to fail, and considering that everything was in good condition before, and that comparisons may be made to demonstrate to the disadvantage of these experiments, our new man is treading on dangerous ground. If he had a bad case to work out, if he had taken hold of a mill which was in a bad and unsatisfactory condition, he could afford to do this; he could afford to try to bring this mill to a point where the methods were like those in his former place. Here, where the conditions are so different, he has no such favorable ground to work in. The first time that he makes a misstep, it is backward, one which brings positive discredit to him—suspicion. It is easy to see where such measures in such a place may lead.

The time is past when a miller has to sustain his position by his ability to make changes in keeping with the spirit of revolution which was once so prevalent. It is possible for him to gain credit by regularly running a mill, by taking what he has and doing his best with it. If the flour is not satisfactory and the proprietors so express themselves, then is time enough to make changes with the view to better results. They will find this out soon enough, and then there is safety in changes; othwise there is not, to the miller. Without such reasons, he will always be regarded with suspicion and distrust, even if it be not expressed. His successes will be taken as a matter of course in fulfillment of his promises, implied or otherwise; his failures will be directly charged against him, with no credits to balance.

The best machinery, the best programme and the best managed mills do not necessarily do the best work with the best wheat. Everything may be ever so complete, but if the miller fails to comprehend, or for any reason to take advantage of that which is set before him, he will fail in doing good work. It is with the most delicate arrangements and adjustments for making distinctions in milling matters that the greatest mistakes may be made. With mechanical provisions for recognizing and caring for all the finer differences in the milling of the stock, there is required a mental provision for distinguishing the uses and necessities for such arrangements. The failure to provide such an auxiliary is the failure of the machine itself. There is no object in having a complete mill unless an equally complete man be chosen to run it. If the finer distinctions be made in the reduction of the stock and its ultimate grading and separations, it is only possible to have these distinctions preserved by operating the machines in the spirit and intention of the original designer. It is a frequent experience of mill builders that the mills with which they take the most pains, those which they study the most carefully, and in which they make the most elaborate preparations for good milling, give them the most trouble. There is in mind a mill which was planned by a prominent and capable mill builder, which failed to such an extent as to reflect discredit on the firm which built it—not because it was inefficient in any degree, but rather because it was too good, too complete for the men who were to run it. They were not organized in a way to recognize or use its better points. One feature of this mill was the gradual reduction of middlings. These men could not see why these middlings should not be "crushed down" at once, and crush them down they did, and the consequence was that when they came to the place in the mill where they should have had their best middlings, they had a lot of flat, feathery stock, which made soft, flat, gray flour, instead of making the best flour in the mill. The builder of this mill was enough of a politician to see a way out of his trouble. He took out that gradual reduction apparatus, as far as it applied to the middlings, and put in millstones, and the result was that the owners were happy. They were confirmed in the belief that smooth rolls would not do for the reduction of middlings, and that the buhrs made whiter, more granular and altogether better flour.

A very large proportion of the flour made in this country is manufactured by very simple machinery and methods. Most of these mills

will one time or another be improved. There will be additions made with the view to the improvement of the quality of the product and having in mind, at the same time, a reduction in cost; at least this latter should always be a part of the scheme. More often than otherwise the idea of improvement in the quality is considered so seriously that the question of cost of production is lost sight of, and while the flour may be better, its cost is materially increased. The feed is richer and the miller eventually poorer. The real improvement in milling does not consist solely in bettering the quality of the flour. That is one side of the question, and a small one. There is no improvement in milling where the main question is not affected in favor ot the owner. By this is meant that there is no improvement where the miller does not get more money out of his wheat by his changes. For if he does not, why should he change? There is nothing in it to him in having better machinery or cleaner flour regardless of cost than does his neighbor. That would be a matter of sentiment, and not business, which latter is the side of this question which is being considered. In times past when there was great strife and great activity because of the radical changes in methods, there was more advantage to be gained by superiority in quality and, in a measure, regardless of cost; and in the enthusiasm of those times, so prolific of changes, this matter of sentiment and personal pride took a rank growth along with other things. But a little time will straighten this all out. The time is past when a few mills will monopolize the trade for a superior article of flour. The number of mills making such flour is daily increasing, and the names which stood up like monuments in the flour trade are less conspicuous because of the strife, activity and skill of their competitors. This change alters the character of the competition. In the future it will be more a matter of cost than of quality. Not that quality will be any the less requisite, but because it will not be so serious a matter with the buyers to get the quality they desire. This state of affairs will call for serious consideration in the cost of manufacture. The matter of yield and percentage of the various grades will force itself prominently into view.

CHAPTER X.

THE CAPACITY OF MILLS—THE INCREASE OF CAPACITY—THE WAY THAT IT IS USUALLY DONE—HOW THE COST OF THE FLOUR MAY BE INCREASED AT THE SAME TIME.

The capacity of a mill is estimated by the number of barrels of flour it will make in twenty-four hours. One mill will grind more wheat and make less flour than another. One mill may make a better yield, but this is not the side of the case to be presented. It is a suggestion. In the nature of things it is not possible to make exactly the same amount of flour each day, nor in the nature of things is it desirable that it should be done. If a mill was built for the purpose of making 250 barrels of flour per day, we all know that it would make more than that amount during part of the time, and less at others. To make an exact amount each day would imply a uniform condition of things which could not exist. If the stock were uniform the miller might not be, and if the miller were uniform in his attentions, from time to time he would be sure to notice changes in the character of the stock under his care which would require handling slightly dissimilar one day or one time as compared with another.

We increase the capacity of a mill. For what? To make more flour; to make more money. If we make more money by the change it is a good one; but the question is as to whether this thing is usually done, or, on the other hand, if the same money used to increase the capacity could not be put to better use by decreasing the cost of production, by adding to the facilities for making pure flour and clean feed. The increase of output by overgrinding in the operation of machinery need not be considered. It is not a pertinent question. There is less danger from overgrinding when business is dull, than when it is brisk. It is clear to the mind of any one who thinks about it, and especially clear to those who have had the experience in increasing the capacity of their mills, that such an operation does not proportionately increase their profits from the year's business, and, from what is known, it is the general opinion that this change as often leads to a loss as it does to a profit.

This increase of capacity is brought about something like this: We have, say, a 250-barrel mill. Business is good; we are making money—can not fill our orders. If we could make more flour we could sell it readily. An increase in capacity suggests itself. The miller and proprietors sit down to talk it over. The miller has a heavy feed on the mill, about as much as "she" will stand, and, in truth, a little more. If they could take a yield in that day's run somebody's hair would stand up. These busy times are very deceitful. Margins are good. We think that we can make more flour, even if it does run a little richer. We think that we can add a little to the feed to gain in the output of the mill. But allow the suggestion that these busy times do not figure out as big as we are led to expect. They are productive of careless milling. But to return to the group who were talking about increasing the capacity of the mill. This is a reminiscence. There are no such groups to-day. It is agreed that they could sell twice as much flour as they are making—have not quite power enough for five hundred, but think "she" would stand four quite comfortably. What is needed to do it? Four or five pairs of rolls are ordered, a purifier or two, and perhaps two or three reels, and in the course of time, a 400-barrel mill is in operation. It was originally agreed that it would take no more help, except maybe a roustabout or two, than for the smaller mill. But when it comes to starting up, they have the extra roustabouts and some inside men besides, "just to help get things regulated," but they never leave.

Look back and see what was done and what was not done. This mill was increased 150 barrels above its maximum capacity by patching on to the reduction a little; by adding to the middlings rolls what might properly have belonged to them without this increase, and for the other smooth roll reductions the means were indefinite, and the miller and proprietors felt that they were lame there, but as they were making more flour they thought they could afford it. Any way, if necessary, they could make some change in the separations which would bring this out all right. Be it remembered that there is no arrangement of separating devices which can atone for marked deficiencies in reduction capacity. No additions were made to the scalpers, very little to the bolting surface. Some of the cloths were made coarser, however, to compensate for this; not the proper thing to do, by the way. The wheat cleaning machinery was entirely neglected, and the other purifiers were little better off. Here are deficiencies all around; everything cramped and

strained. The reductions could not be so good as before; the bolting much worse; the wheat cleaning machinery positively wasteful and insufficient. The purifying system, which was not too good before, now has its machines overloaded with middlings badly formed and poorly dusted. The mill is started. All recognize that the results are not satisfactory, but say that this is incident to starting new machinery, and in the meantime they get used to things as they are, forget to compare, and are partly satisfied for the time. But the buyers realize the difference. They reject, protest, and perhaps claim rebates. The miller protests, and either pays or does not pay the claims. He says "he may have a little poor flour in starting; who has not?" A few days later he has more objections from buyers. "All nonsense; the flour is all right. If the market had not gone off we would never have heard a word about poor flour or anything of this kind." But, in the course of time, this thing quiets down; no more objections. Does this mean that the flour has reached the original standard of excellence? By no means. It means that they now realize the true position of the flour, and pay correspondingly less money for it. The miller fondly imagines because they do not object that the flour is as good as ever, but he may notice that the old buyers who were running on his flour are taking less of it, if they have not abandoned it altogether. The miller has had to search for new customers, who buy it distinctively on its merits, regardless of its previous good name. The flour occupies a lower place in the market. It is worth less money. But this is not all—it costs more. The yield is astonishingly high.

The flour costs more and sells for less since the increase of capacity. The increase in cost is realized; the decrease in value is not. This means more millwrighting and more expense, and they finally settle down to a yield which is not quite as high as the last but higher than the old one.

There is another element of loss, and that is the trade for the dull season. The miller scattered his friends just at the wrong time.

No one will consider this picture overdrawn. It is a common experience rather than an uncommon one—a condition of things developed by prosperity. It is one of the things from which the mills are now suffering, and with business as it is, all think that they cannot afford to change the mechanical state of affairs; but it will be done, however

gradually. It is these tight times which will do it. Prosperity made us careless, but adversity will make us careful.

To revert to the 250-barrel mill illustration. How much better it would have been had the owner decided to cut down the cost of the flour and add to its quality by putting in this machinery. It would take a good deal of courage to rearrange a 400-barrel mill to make 250 barrels of flour, but is it not more certain to make money? It does not take much courage to go ahead when the money is in sight. Reduce the cost of production and increase the value of the product.

CHAPTER XI.

WHEAT AND FLOUR CHEMICALLY CONSIDERED—THE PROPORTION OF ALBUMINOIDS AFFECTING THE COMMERCIAL VALUE—THE RELATION OF CHEMISTRY TO THE MARKET—A GRAPHIC EXHIBITION OF THE CHEMICAL QUALITIES OF THE VARIOUS WHEATS—THE CHEMISTRY OF FLOUR—FIBRE AND ALBUMINOIDS AFFECTING THE PRICE OF FLOUR—A GRAPHIC EXHIBITION OF THE CHEMICAL QUALITIES OF VARIOUS MILLING PRODUCTS.

When anything is said to a miller about the chemistry of wheat, when he sees, in the course, of an article or milling chapter, chemical expressions and chemical discussions, he is inclined to look over that article very hastily, to say the least. The writer does not lay claim to an extensive knowledge of the chemistry of wheat, and, for that reason, is not in a position to disturb any one by an extensive dissertation involving the use of chemical knowledge. He feels disposed to accept the expressions of others who are in a position to know more about this subject than would be possible with him unless this branch of study were followed to the exclusion of all others. Furthermore, he feels disposed to accept the conclusions of such authorities without wading through an account of the means of reaching such conclusions. Prof. Clifford H. Richardson, assistant chemist of the department of agriculture at Washington, in his bulletin No. 4, in which he presents "An Investigation of the Composition of American Wheat and Corn," in explanation of the analysis, says: "The determination of the albuminoids in connection with the size and condition of the wheat, settle, so far as physical and chemical examination can succeed, the peculiarities of the samples in hand." From the miller's standpoint this is all that it is necessary to know, and, as the size of the berry is not a very important matter to him, the relative percentage of the albuminoids is the principal thing after all. There is a distinct relation between the percentage of albuminoids and the commercial value of wheat, or, to express it differently, there is a distinct commercial relation between the proportion of albuminoids in various wheats and the flour made from those wheats. We may take a table which shows the albuminoids, as does the one which

follows, and select the wheat which makes the highest priced flour. This is a convincing fact; it is the method of estimating the worth and value of wheat and flour—that is, in a relative way. The flour from the wheat which has the largest proportion of albuminoids is worth more money, and sells for more than does flour from a wheat which has a smaller proportion of albuminoids. We may take as illustrating and verifying this statement, the hard Dakota wheat, with its 15.54 per cent. of albuminoids. We find on comparing it with Ohio Fultz, which has 12.95 per cent. of albuminoids, that there is the relative difference in the flour made from those wheats. There is nearly always fifty to seventy-five cents difference in the selling price of those flours in favor of the one which has the largest per cent. of the albuminoids. There is the Mediterranean wheat, with its 16.1 per cent. The price of the flour from such wheat does not quite reach that of the flour produced from the wheat of the far Northwest. It would be possible to take two milling samples of wheat and so mill them that the one which contained the larger proportion of the albuminoids would sell for the less sum of money. This would be for mechanical reasons, however—for the reason that one wheat was not milled as well as the other. But where the milling is approximately uniform there will be just the difference in the price of the flour which is indicated above, unless the wheat be of such a character as to make it impossible to mill it properly. In former years, previous to the introduction of the new process, hard spring wheat would have come under this head.

New process milling, intelligently carried out, removed the former difficulties in the way of handling spring wheat. New process milling took the wheat, made it into middlings, cleaned and purified it, and made it into flour. It took the wheat which was rich in albuminoids, and by so handling it as to remove the deleterious portions, it put the flour at the head of the list. It is just as impossible to make an article of flour out of a wheat which is deficient in albuminoids that will compete with one which is not so deficient, as it is for a corn mill to compete with a wheat mill in supplying the same goods. It is not possible for a mill which handles Fultz wheat ever so skillfully to compete with a mill which handles long berried Mediterranean wheat even tolerably well. The writer has known millers around through Ohio and Illinois to periodically tear to pieces and reorganize in order to compete with some small mill which was able to sell its flour at much higher

prices in the eastern markets than they. It took a long time to find out the reason. It was discovered that one mill was running on Fultz wheat and the other on long berried Mediterranean. Fultz has 12.95 per cent. of albuminoids and the Mediterranean 16.1 per cent. of albuminoids, and it is altogether impossible to supply the deficiency in milling. The mill which handles the better grade of wheat will get more money for its flour than is possible from Fultz wheat. The same is true of the various varieties of Northwestern wheat, and may be illustrated in a very practical way by recurring to the records of the mills which use the better varieties. It may be well to say that the albuminoids in the wheat imply its nutritive value, and at the same time indicate the proportion of gluten. In considering wheat in a milling sense it might be in order to say something about the physical qualities of its structure, but being a subject that is well understood, and one that is so prominently brought to the mind of the miller from time to time, and as all wheat is approximately the same in structure, time and space will not be taken to consider this matter. The following table illustrates, in a graphic way, the relative sizes of wheat and proportions of albuminoids in the various wheats named:

	Grammes.	Albuminoids.
VIRGINIA		
Osterey	3.565	12.60
Red	3.465	11.2
WEST VIRGINIA.		
Early Amber		10.85
Osterey	3.392	11.3
ALABAMA.		
Dallas	4.447	11.20
OHIO.		
Clawson	3.3	13.83
Michigan Amber	4.8	11.73
Zimmerman	3.328	13.13
Silver Chaff	3.27	11.73
Lancaster	3.887	15.05
Golden Straw	3.759	13.48
Rice	3.393	14.18
Mediterranean	3.94	16.10
Fultz	3.505	13.13
Egyptian	3.565	12.95
MINNESOTA.		
No. 1 Hard	2.926	13.83
No. 1 Hard	3.57	15.23
Selected Samples No. 1 Hard	3.354	14.40
DAKOTA.		
Average of the wheat crop of '83	3.151	14.54
COLORADO.		
Average of the crop of 1882	4.283	13.04
Average of the crop of 1883	3.941	11.74

(5)

The falling off in the average of albuminoids in Colorado wheat is shown as follows:

Crop of 1881	13.42
Crop of 1883	12.19

Below we give a table which indicates the quality of a number of representative wheats of the spring and winter wheat country:

	Weight of 100 Grains.	Albuminoids.
Minnesota, No. 1 Hard	3.57	15.23
Dakota, average crop of 1883	3.151	15.54
La Moure county, Dakota	3.074	18.03
Ohio, Mediterranean	3.94	16 10
Ohio, Fultz	3.505	12.95

The next table shows the difference between two wheats, spring and winter, grown on Dakota soil:

	Weight of 100 Grains.	Albuminoids.
Winter wheat	3.513	10.68
Spring wheat	2.755	14.35

What was said under the head of wheat as regards the proportion of albuminoids might be said, in a limited way, of flour. Wheat which will produce flour that contains the largest proportion of albuminoids, as we understand it, is the most valuable wheat, and flour which contains the largest proportion of albuminoids and the smallest proportion of fibre and other impurities is the best flour. It cannot be said, in the broad way in regard to flour, that that which contains the largest proportion of albuminoids is the most valuable flour, in that the impurities which there may be in flour have a tendency to destroy the value given to it by the large proportion of albuminoids. Thus, in estimating the value of flour, we have to consider it on the basis given above; that is, with reference to the small proportion of fibre, as well as with reference to the proportion of albuminoids. Below is given a table which illustrates, in a graphic way, the proportion of albuminoids and fibre in the various stocks named. We shall notice that the value is given to the flour by its freedom from fibre. The bakers' flour from Pillsbury & Co.'s mill contains .33 per cent. of fibre and 14.88 per cent. of albuminoids; the patent 12.95 per cent. of albuminoids and .18 per cent. of fibre; the low grade contains 17.95 per cent. of albuminoids and .93 per cent. of fibre, which latter element, in that the proportion is large, keeps the flour very low, notwithstanding the fact that the proportion of albuminoids is high. Another thing which may be noticed, as exhibited by these tables, is that the closer to the bran the reductions approach, or rather as the reductions advance toward the finishing process in the

cleaning of the bran from the first to the sixth break, the proportion of albuminoids increases. The proportion of albuminoids is larger on the last break than on the first.

Table showing the proportion of albuminoids in the various products of C. A. Pillsbury & Co.'s milling:

	Albuminoids, Per cent.
Wheat as it enters the mill	14.18
Cockle and screenings	13.65
Scourings removed by cleaners	11.55
First break chop	12.95
Second break chop	12.60
Third break chop	12.70
Fourth break chop	14.18
Fifth break chop	15.75
Sixth break chop	17.28
MIDDLINGS UNCLEANED.	
No. 1	13.48
No. 2	13.30
No. 3	13.13
No. 4	13 83
No. 5	14 53
MIDDLINGS CLEANED.	
No. 1	13.13
No. 2	12.78
No. 3	13.13
No. 4	13.30
No. 5	14 35
TAILINGS FROM PURIFIER.	
No. 1	16.10
Nos. 2, 3, 4 and 5	14 35
No. 6	14.53
Re-purified mids	14.88
FINISHED FLOUR.	
Bakers'	14.88
Patent	12.95
Low grade	17.95
Break flour	15 40
Flour from tailings, average	13.40
Germ, average	30.08
Bran dust flour	13.65
Dust from dust catcher	14.14

Table showing proportion of albuminoids in the various products of Herr & Cissel's milling:

	Albuminoids, Per cent
Mixed winter wheat, cleaned	12 78
First break	13,48
Second break	13.13
Third break	13.13
Fourth break	13.65
Fifth break	15.40
Sixth break	12.10
First middlings	10.68
Second middlings	10.50
Third middlings	11.65
Patent flour	9.98
Clear flour	11,03
Low grade	14.18
Feed middlings	16.45
Bran middlings	16 45

The products furnished from C. A. Pillsbury & Co.'s mill are so complete as indicating the various divisions and classifications of products as to provide means of obtaining exact and complete chemical knowledge of the chemical effect of the processes of manufacture on the various products. The albuminoids from the tables of Mr. Richardson have been selected as indicating the nutritive qualities of the various products, and the graphic tables which are given bring into view some very noticeable facts.

It may be noticed that the cleaning of the middlings makes very little difference in the proportion of albuminoids. The albuminoids of the

tailings show very large, owing to the germ. The low grade flour is the richest in albuminoids, bakers' next, and the patent is the lowest. The showing made by the germ is quite pronounced. It is the large proportion of oil and fiber which the low grade flour contains that destroys its bread-making properties.

Mr. Richardson's table makes the following showing of the proportion of fiber in the different grades of C. A. Pillsbury & Co.'s flour:

	Fibre, Per cent.
Bakers'	.33
Patent	.18
Low grade	.93

We may see that the value of the flour is affected, first by its purity and second by the proportion of albuminoids. We may know that if the albuminoids be not present to the desired extent, the flour will not take a high rating in the market. It is the experience that the relative value placed upon flours in the markets by the ordinary trade conditions and the relative value indicated by the chemical constituents are the same; and it may not be out of place to say that in time flour inspection may include a chemical analysis which will fix its proper standard. It would be said that flour contains a certain proportion of nutritive and glutinous qualities and a certain other proportion of deleterious qualities, and for that reason belongs to a certain grade and is worth so much money. This would be systematizing and fixing upon an exact and intelligent basis the inspection of flour. Such a method would place the inspection of flour outside of mere human judgment and within the scope of absolute formulated and scientific information. It would place the grading of flour outside the range of guess work and within the range of absolute certainty.

CHAPTER XII.

FLOUR FROM A MILLING STANDPOINT—DEALERS IN FLOUR THE BEST JUDGES—THE COLOR AND STRENGTH OF FLOUR—THE DOUGHING OF FLOUR—GRANULAR FLOUR—PATENT FLOUR—LOW GRADE FLOUR—HOW TO GRADE FLOUR—THE PLACE TO STOP MAKING FLOUR—THE BEST MILLER.

The dealers in flour are better judges as to its quality than the makers. This is a general statement, and of course there are exceptions to it. But take the sellers and buyers of flour in the large markets and contrast them with the millers of the large manufacturing centers and the comparison will be to the disadvantage of the latter. The facilities for knowing flours are better in the flour markets than in the mills. Judgment or knowledge is gained by experience or comparison; differences cannot be recognized without comparisons. The facilities for such examinations are the best where there is the greatest variety of flours. There is no better place to learn about flour, to be forced to recognize the smallest and most minute differences, than on the New York Produce Exchange. It is here that one sees nearly every flour manufactured in the United States. It is here that the best flours are most readily appreciated and where the demands of the trade are the most fastidious. On this exchange there is less dependence put upon brands and trade marks, and more upon the judgment of buyers and sellers, than any other market in this country, to say the least. There is no place better calculated to arouse a miller to the necessity of good judgment in the examination of the products of his mill. There is no place which will more thoroughly take the conceit out of a miller than this same place. If a miller will give himself half a chance, he can determine his exact position with reference to other millers; he can convince himself with very little trouble.

There are two main points to be looked at in the manufacture of flour. Color first and strength next. It might be said that the order of their importance is not correctly given, but when one calls to mind the fact that the darkest flours are often the strongest, it is not difficult to

see this point. What is wanted is white and strong flour. If it is very white and of very little strength it will not bring a high price, or if it is very strong, and of poor color, it may be not so good. One of the best color tests was first brought prominently to notice by Emmerich Pekar, the author of "The Wheat and Flour of Our Earth." His method was to place side by side two or more flours on a card or board, or a piece of glass, and after pressing them down with a spatula, to dip them in water. Such a process emphasizes the difference in color, and makes it much more conspicuous than in the dry dust. But this merely gives the comparative colors of the different flours.

The doughing test gives both color and strength. Of course it is not so quickly done. One great fault noticed in doughs made by millers is that they make them too dry; they get too much flour in proportion to the amount of water used. This kind of doughing does not show the absolute strength or sponginess of the flour. It works dull and heavy, and cannot show its better qualities if it has them. A dough which is too dry does not spring back, or show spongy or elastic qualities. The proper consistency cannot be expressed in words, but with these points practice will determine what is correct. A dough which is neither too soft nor too dry should be allowed to set a short time, to allow the granules of flour to dissolve, after which it will show what there is in the flour. One great mistake made by people who are not experts is that they do not get the proper mixture the first time; that is, they get it too wet and then dip it in the flour, or add more from time to time until the desired consistency is obtained. Such doughing cannot make a correct exhibit of the qualities of the flour. It will show it worse than it is every time. For example, it will be darker in the wet and dry dough than it would be if the flour were all mixed at once, and furthermore it will not show its full strength. Another thing that this kind of doughing does is to make the flour sweat and get sticky in working. Under other circumstances this would indicate that the flour was dirty, that is, improperly purified and bolted. It is a very easy matter to make an appearance of a difference of from twenty-five to fifty cents a barrel in two flours of equal value, or in two doughs of the same flour. This may be done carelessly, ignorantly or purposely. If done purposely the above method will accomplish a good deal, or if two doughs be properly made, quite a difference can be made in handling. For instance, say a flour buyer is doughing your flour against another and de-

sires to make it appear that his is the best; he may dough them all right as to consistency, but may make yours appear weaker by working it down; or a not uncommon habit is to allow the dough to get warm by holding it in the body of the hand while working his own with the ends of his fingers. This leaves his flour cool and strong, and yours warm, soft and sticky. Another less flagrant deception is to work the flour which it is desired to misrepresent nearer the body of the hand—not on the ends of the fingers—but rather up as much on the third joint as possible. This makes a dough warmer and works it down quicker than by working it as near the tips of the fingers as possible, which will keep it cooler. In fact, by working a dough this way, it can be worked a good while without letting down or getting soft and sticky. Another thing which gives one flour prominence in strength over another is by spreading it out thin and exposing it to the air or a draft, which makes it cool and tough.

Flour will work stronger in a cool atmosphere than in a warm one. Cold water will make a dough start out stronger at the first working than will warm water. All these little tricks of doughing cannot do any permanent good, or a victim to them any permanent harm, but it does no harm to know there are such. As far as the experience of the writer goes, he cannot see that any information can be gained in regard to them by drying out the doughs, by putting them in the stove or otherwise. The fact of one flour drying out whiter than another of the same general grade in this way does not indicate anything in reference to their baking qualities. For instance, take Fultz wheat clear, and Mediterranean wheat clear; the latter will almost invariably dry out darker than the former. But at the same time it will bake a great deal whiter, and the proportional difference in the color of the two flours baked will be the same as between the wet doughs. The Mediterranean flour will show whiter in the wet dough than the Fultz wheat, and proportionally whiter in the bread, but as said before, the Fultz wheat flour will dry out the whiter in the ordinary method of making doughing tests. It is for this reason that the dry dough does not signify anything in testing two flours. If one knows just what kind of wheat they are made of it may enable him to tell something about the milling—otherwise not.

Sharp, granular, or large-grained flours are not as white in color as small-grained, soft flours. They show their impurities to a much greater extent. The difference is in appearance only. The specks and impurities are of such a size as to be readily seen in the larger grained flours,

and for this reason a soft-grained flour may contain a much larger proportion of impurities and yet show cleaner than the larger grained flour with which it is compared. But this is not the reason for the difference in color. The granules of a large-grained flour cast shadows one upon the other in such a way as to make the whole appear darker than where the granules are smaller and the shadow less. To explain this, a gravel bed looks lighter than a pile of boulders of the same geological formation. Or, again, the flour from middlings shows whiter than the middlings themselves, notwithstanding the fact that it may not have been bolted. Say one was taken before going through the roll and the other after. It is a mere difference of size and not of composition. The largest particles cast the heaviest shadows, and consequently show the darkest.

In the sale of flours in certain sections of the country this thing has to be met, more particularly where they rely on the spatula and the thumb nail. The writer has seen a miller set a middlings buhr by his nose. Say he had dirty middlings, as such millers generally have; he would set the buhrs so close that he could smell them, and then raise them the merest shade. This miller made white flour, but the flour did not make white bread or a large loaf.

Patent flour is not any particular part of the wheat berry. It is not as strong as the bakers' or clear flour, and not as strong as the low grade. We frequently hear it said that the patent flour is only made up of the harder or more glutinous portions of the wheat. The low grade, or the flour from next the bran, would come as near meeting this definition as does the flour from the middlings in the present system of manufacture. In the old system of milling with the millstone, and especially the low grinding system, the middlings were that portion of the wheat which was best calculated to resist the action of the millstone; that is, it was the hardest and most glutinous portion. The present system of making middlings with corrugated rolls does not depend upon the varying hardness of the different portions of the wheat to make middlings. Of course where the wheat is harder it will be more brittle; but by this system the making of the middlings is not merely an incident in the manufacture of flour. It is the principal purpose in the reduction of wheat by corrugated rolls; and by this method the wheat is *broken* into middlings, not *ground* into flour with a portion incidentally remaining as middlings, because of its hardness. For this reason patent flour,

or the flour made from middlings, according to the present methods, does not necessarily mean that it is the flour from any particular part of the wheat berry, as is frequently understood. As we now understand it, the purpose in milling is to make the largest proportion of middlings, with the intention of making a proportional product of pure flour. And whereas the middlings were previously an incident of reduction and not the desired portion, it is now the reverse, the middlings being in larger proportion and the flour or dust of their preparation being the incident. Patent flour means pure flour, and a single granule of clear or low grade flour may be as good as a single granule of patent flour, but its value is depreciated by its association with less valuable material.

There is something which may be said on the low grade question, and that is, bluntly, that there should be two low grades instead of one. There is just one place to stop making flour, and that is where the lowest grade of flour and the best portion of the feed approximate the same price. There is no more reason for running all the low grade into one packer than there is for so doing with the higher grades. The logic which advises the throwing away of any quantity of superfine flour in order to bolster up or to keep the low grade "rich enough," cannot be accepted. If the desired grade is XXX, anything which will lower that grade may be put in another barrel, and not sold at the same price as feed. A small proportion of low grade flour will lower a much larger quantity of high grade. A quantity of superfine flour may and often does contain fifty and sixty per cent. several grades higher, a large portion slightly above it, and a small quantity of fine or other lower grade, which serves to lower the whole. The above system of grading is according to St. Louis methods, and, by the way, is the best system in this country for low grades. It has been adopted by the Indianapolis board, and should be recognized by the principal markets as standard on winter wheat low grade. This method of separating the low grades does not necessarily require a packer for each. They may be run into sacks, graded and packed when convenient. This is one element of Hungarian milling. It often happens that two or three per cent. of the lower end of the red-dog may be spouted out in this way, the principal product being materially improved and the smaller portion of a quality above the price of feed. The practice of running everything below a choice clear or bakers' into one grade, is an absurdity. As to the yield proper, it is a matter of detail. The question as to how low it can be

made can be decided by putting in enough machinery to make the last flour and the feed meet in price, or as nearly so as will represent the difference in cost of manufacturing flour or feed.

As a matter of practice, we cannot make these separations as exact as is here implied. It is easy to understand, if you stop to think about it, that the range from a good clear flour, such as a fancy or a choice, to the super, is too wide to be natural or right. In most mills there can be found flour running into the low grade mixture which is well above superfine in grade, and this being the case, there must be other products which are well below the superfine. Now, if we could make arrangements to separate these extremes, rather than to run them together, we would have a certain proportion of flour which is quite good, or intermediate, in quality, and a certain other proportion which is below the super standard, and we could then judge exactly whether it would pay to run them together or not. The general experience is that it does not. Sometimes we know of millers running patent, clear and low grade all together, for the purpose, as they say, of making a "cheap mixture." It generally makes it so cheap that there is no money in it.

There are those who begin throwing stock into the feed pile where others begin to make low grade flour. This is where the lowest grade of flour is XXX, which necessarily implies that there must be still other and lower grade flour going into the feed pile. What better thing could there be to do than to take this latter flour and put it into a packer by itself? People who say that a barrel of winter wheat flour cannot be made out of less than four bushels and forty-eight pounds of wheat, or more, are making a low grade which will pass XX and XXX in St. Louis. They are sending the rest of the flour which would go to make up a lower yield into the feed. Millers who are making these fancy low grades frequently pride themselves on it, but as a fact it is not a matter for pride, because it is a source of loss.

The miller who adds the largest proportion of value to a bushel of poor wheat is getting a better yield than he who adds a smaller proportion of value to a bushel of good wheat. To consider the question of yield as broadly as is here implied, we have to take into account the patent flour, the clear flour, the low grade flour, and the feed, making the best grade of patent flour and the cleanest feed go together in the matter of yield. Then we should add its quality, and the quantity and quality of the clear and low grade, and finally, the value of the feed.

Thus we see there is more in this than a casual glance would indicate. Now, what is the best yield in milling? It is such as will make the best yield of patent flour and the most of it—that which will make the best clear and the most of it, and finally, that which will make the best low grade and the most of it.

We hear millers talk about the small quantity of low grade which they make. Now that is all right, if it means that they so handle their stock that there is only a small portion of low grade stock in the mill—only a little material left out of which to make low grade flour. What we want to do in order to get a good yield and get the most money out of the wheat is to use our best endeavors to get all the high grade flour we can out of it, and when we realize that we have done the best thing possible in this process, we must be equally zealous and active in getting all the low grade flour we can out of what remains. The separations should be as exact as possible; we do not want feed in the flour, nor flour in the feed. Again, we do not want low grade flour in the high grade packers, nor high grade flour in the low grade packers. All this influences the yield—of money.

We frequently hear people say that it does not pay to make a good grade of flour in their market. Such people generally say that what they want to do is to make a "good, common, straight grade," whatever that means. English travelers in this country used to talk that way. A few months ago a milling paper contained an article advising the millers to make more low grade, saying that they would make more money in that way. High grades, it said, were too numerous. To go a little farther with these illustrations: The writer met a miller a few weeks since who was mixing what he called the sixth reduction middlings, which were of a quality suited to red-dog, with his high grade middlings. When asked if he thought that paid him, he said yes; that he did not think it paid him to make too high a grade of flour. It was suggested that he mix a little sawdust, and if the community in which he lives is of the kind he described, probably he will prosper. Furthermore, a recent article advises millers not to make any high grade flour. Now, if these things were not so common, it would be a waste of time to write about them. But this idea is more prevalent than would be generally supposed. Now, every mill cannot make this highest grade of flour; but the thing for each mill to do is to make the best flour which can be made in that mill, and as much of the high grades as possible.

Under such circumstances it costs no more to make the flour of the best grade possible in each mill than it does to make it poor, mean or ordinary. The cost being equal, it is better to sell a good flour for a medium price than it is to sell a medium flour for a medium price. The forme is sure to pay the best in the end.

CHAPTER XIII.

THE RELATION OF THE YIELD TO THE QUALITY OF THE FLOUR—THE PROPER PRODUCTION OF LOW GRADE—THE LIMIT OF FLOUR PRODUCTION—THE PROPORTION OF MILLING MACHINERY—UNIFORM LOW GRADES NOT POSSIBLE WHEN HIGH GRADES ARE UNIFORM—THE PROPER PLACE TO DETERMINE THE AMOUNT OF FEED ON THE MILL.

If a miller makes a very excellent quality of flour, it is often imputed to him that he takes a large amount of wheat out of which to make a barrel of flour. There is no reason for such a conclusion from such a basis. As every one knows, the quality of the flour is dependent upon the quality of the separations, and where one miller makes a better flour than another, he does it by making better separations; and in the ultimate result he gets the high grade stock into the high grade packer, and the low grade stock into the low grade packer. It does not follow that because he makes a high grade patent or clear, he throws the low grade flour into the feed pile. Or, to go into this thing a little farther, the making of superior high grades does not imply that questionable stocks are all run into the low grade or red-dog. The same good judgment which makes a superior high grade flour will also discriminate and use the same methods with reference to the intermediate and lower grades. In order to maintain this high standard mentioned, it is merely necessary that exact separations should be made. It does not mean that a large amount of high grade stock should be thrown into the low grade or into the feed pile in order to get a little high grade flour. Good flour is like good anything else; it is simply the absence of bad.

The best mi ling is that which gets the most money out of the wheat. This means to make all the high grades possible, and when through making high grades, to make all the low grades possible. One division may be independent of another. The fact that one miller makes more high grade than another, does not always signify that he has the best means. The fact of one miller making more low grade than another cannot necessarily mean that he is less skillful than another. It may mean that he has more of a mill to make it on, and consequently makes

more of it. He gets more low grade stock into low grade flour than his neighbor and less into the feed. According to this, the best milling, in the sense of the definition given, does not always locate the most skillful miller. Looking at it in a personal sense, the most skillful miller is he who does the best with what he has. He may do this and still not gain the position which he would have if better means were at his hand and he were doing the best milling in a milling sense.

There are a great many mills in the country which are doing good work as to quality and poor work as to quantity. The flour is good and the yield high. There is another class where the yield is reasonably low, and the flour not so good. The reason for this is to be found in the incompleteness of the mills. There is not enough to them. There is nearly always enough mill to make good flour by throwing good stock into the feed bins. There are very few mills which can make good high grades, a fair proportion of low grades, and still finish well. In the effort to do this when there is not enough mill, things are mixed, high, low and intermediate together, and the result is correspondingly unsatisfactory. The remedy for this is more mill or less work.

In putting in extra reduction machinery for the purpose of getting a better yield, it is not always necessary or advisable to disturb the arrangement of the other parts of the mill. All that remains to be done, and which, considering the object in view, cannot but be satisfactory, is to take the better portion of the material going into the feed pile and reduce and bolt it by itself. In this way the question of yield can be settled, and the point which can be reached is limited only by the desire of the miller. He can go on reducing and bolting in this way until the feed and the flour are the same color. This, of course is not desirable; it is an extreme illustration; but it is desirable to keep on making flour until the feed and the lowest grades of flour approximate the same price. It might be said that these last lower grades would injure the low grade proper. That is no doubt true, and it is for this reason that more than one low grade should be made. There are those who will say that this is too much trouble, but by the method named one can make the ordinary low grade flour to be sold at the usual price of such flours; and, in addition to this, flour can be made which is higher in price than the feed. Such a difference will represent a difference in profit when due allowance is made for the difference in the cost of manufacture. Anything which makes money cannot be said to be troublesome.

Assuming that the various parts of the mill are properly proportioned for the reduction of the given quantity of grain in a specified length of time, it is fair to presume that there must be certain guides as to whether the mill is overworked or underworked. In speaking of the proper proportion of the parts of the mill, are meant such arrangements or provisions that one part of the mill will take care of, in the desired manner, the material prepared for it elsewhere, and at the same time will properly handle such material with reference to future manipulations. For instance, there should be purifying capacity for the middlings to be handled, or reduction capacity for the same, and so on throughout the entire mill, so that no one part will have more than it ought to do, while another has less. As has been said, under such a condition of things, it is fair to presume that there would be some proper guide which would indicate whether a mill was underworked or overworked. For instance, if the feed is rich and the other parts of the mill appear to be doing their work within the range of possibilities under existing circumstances, it will be clear that there is too much feed on the mill. On the other hand, the fact of the feed being clean would not indicate that the feed on the mill was too light, clean feed being desirable. But it may be possible to have clean feed and at the same time to have pulverized feed going into the flour, which means that the stock was cleaned, and the flour taken out, before the low grade material reached its proper stage in the mill, implying that the feed on the mill was too light, which would mean that there was pulverized bran and other feed going into the low grade flour packer, and low grade flour going into the higher grade packers. The fact of stock going through a 12 or 14 cloth does not mean that it is flour. If it did, a barrel of flour might be made out of 196 pounds of cleaned wheat, with the addition of 6, 8, or 10 pounds for invisible or unaccountable loss. The mill being properly proportioned, as stated before, and in the light of what was just stated with reference to the feed and low grade flour, it is fair to say that the judgment of the miller as to whether he has the proper feed on the mill is worth the most, is more certain to be right, when formed by an examination of the stocks at the tail ends of the mill, by which is meant the feed, the low grade flour, and the last of the bakers' or clear flour reels. It is a safe way to run a mill with reference to the cost and quality of the products. It means a uniform yield and a uniform flour, as to the high grades.

It is not possible to have uniformly clear feed, uniform high grades of

flour, and at the same time keep the low grades at a fixed standard. There must be some place to account for the difference in the quality of the wheat ground. If one makes uniformly clean feed, he cannot make uniform flour; or, if the flour is uniform, the yield, as influenced by the feed pile, cannot be the same from day to day. As it is desirable to make clean feed all the time, and high grade flour up to a fixed standard, it follows that the irregularities must come in the low grades, which latter should be inspected as they are packed, and the different grades marked. Experience shows that there is a constant variation in the quality of the low grades where the other flour is exact as to quality one time with another, and the feed uniformly clean. This difference is not great, but it is a marketable one. It is a very simple matter to inspect low grades as they are packed. When the mill is not too large, it can be done by the head miller, or some other person whose time is not entirely taken by routine work, such flour being packed out at a regular time each day.

In a stone mill, a good place to determine the proper feed is at the cut-off from the last chop reel. If it is too thin and sharp, put on f ed; if too soft, take it off. In this way the chop flour is sure to be uniform, and the fine middlings which tail over this reel cannot contain an unusual quantity of dust or flour. In some mills it is possible to run these reels with uniform results without changing slides except on rare occasions, by changing the feed on the buhrs, as stated above. In this way the flour is not liable to be hurt by radical changes from hard to soft wheat. As an illustration of this point, the experience of one year is recalled, when the harvest months were hot and rainless, and the new wheat came in very hard and brittle, much more so than the old wheat which was being ground. It so happened that the supply of old wheat was exhausted late one afternoon, and, as business was pretty brisk, it was necessary to begin grinding the new wheat at once. It was so hard that it flew all to pieces, bran and all, as soon as the millstones touched it. This was calculated to make the cut-off from the last chop reel run sharp, but the miller on watch, who had been drilled into the idea of determining the feed of the mill by this spout, gave the buhrs work enough to do to bring it around to the proper point. Of course the grinding was not as good as it was with the proper feed, but it kept the flour up, and the packer register the next day showed that the mill had made 25 per cent. more flour than ever before. If the miller had been

running by the slides under the conveyors, it is hardly probable that he would have reduced the capacity of his chop chest one-half, and even if he had, it would have been done so gradually, and taken so long, that in the meanwhile poor flour would have been made. In looking back after the thing is all over, one might say that the miller could have made the proper changes at the right time, but when one thinks that the mill might have been run for months with the variation of from four to eight slides, it is not at all unnatural to conclude that there are very few millers who would have had the stamina to cut out from twenty-five to thirty feet of flour cloth at one time. Such a plan is suitable only to stone mills of small or moderate capacity. Large buhr mills or roller mills would involve work disproportionate with the result. But for small mills, the first plan suggested is feasible. Other things being equal, it is not an unnatural thing to grind as much stock as can be finished properly, and the proper amount is most clearly indicated at the tail end of the mill, if the mill is properly proportioned.

CHAPTER XIV.

OFFAL—SCREENINGS, FINE FEED, AND BRAN—THE PROPER PLACE TO STOP MAKING FEED—BRAN COMPRESSING MACHINE AND ITS EFFECT ON THE MILLING TRADE—WEIGHT OF THE FEED NO GUIDE TO THE YIELD—BROAD, CLEAN BRAN INDICATIVE OF GOOD GRINDING.

Offal is that part of the milling product which is not sold as flour. It includes the foreign impurities from the wheat, the bran and the tailings from the low grade flour reels. This latter product has different names in different parts of the country. It is called shorts, middlings, feed middlings and fine feed. Fine feed is the most common name. The proportion of offal from the wheat, the foreign impurities therefrom, varies with different qualities and kinds of wheat. The average may change with different crops. One year there will be more screenings and light grains than another. It would hardly be worth while to give tables or statements which would represent the average amount of such offal at any one time, as the quality of stock varies in different parts of the country. For this reason statements or exhibits of this kind would be misleading, or, to say the least, valueless. Another reason for not giving these statistics is that, as regards the contained foreign impurities, the proportion of stock taken by different millers from wheat of the same quality may vary, and it may be that he who would take out the larger proportion of stock with his wheat cleaning machinery, would do this without adequately cleaning his wheat. It does not follow that he who takes the largest amount of stock from the wheat in cleaning it, cleans it the most perfectly. One man may take out less than another and still send the wheat to the reduction machines in better order, in better shape for reduction. One miller may crowd his cleaning machinery, or it may be imperfect in arrangement, or the system may not include a sufficient number of machines, for which reasons he will clean his wheat in a wasteful way. He will not only take out stock which belongs to the wheat, but will leave in that wheat impurities which should be removed. There is material for offal in one part of the country which does not exist in another; for instance

cockle. For the reasons here given, it would hardly be in order to give statements of the probable amount of offal which would be removed from the wheat. The conditions are so variable that nothing which could be said would have general application.

The offal from the reductions and separations varies in quantity and quality with the yield. During the earlier times of millstone milling the effort was to clean the bran at the first reduction of the wheat, and it was only during the later years of that process—a few years previous to the introduction of the new process methods—that any large number of millers reground the bran. It was not an unusual thing to hear it said among millers that they did not propose to make flour out of bran, that they would grind wheat and not bran, and all that. They would say that the bran was worth as much as the low grade flour, and often this was said without figuring to test the accuracy of the statement. The dividing line between feed and low grade flour should be fixed by the price of both products. When feed is the same price as flour there is no need of milling it farther. At the same time that the feed is milled it should be borne in mind that it may be done so closely, so much of it may be pulverized, that it will depreciate the low grade flour to a very considerable extent, and to an extent which would render the operation unprofitable. Bran may be successfully reduced and cleaned profitably as long as the product of each reduction will sell for more than the feed. Now, it might be unprofitable to run the product of the various bran reductions or feed reductions together. The lower product of flour would contaminate the higher product, but there is no reason why the higher and lower products of low grade flour should be all run together as has been explained elsewhere, and for this reason bran may be cleaned according to the dictates of the market.

The red-dog feed may be the cause of a great deal of loss to the miller. It is more common to speak of clean bran than of clean red-dog feed. There are more and greater losses through carelessness in the cleaning of the red-dog stock than there is in the cleaning of the bran, for the reason that it is readily perceptible in the latter, while a great deal of stock may pass over in the red-dog feed without being noticed.

Some few years ago, the Millers' National Association offered a prize of a thousand dollars for the best bran compressing device. Such a machine would make it possible to export bran to the other side of the

ocean—to Great Britain and the Continent. The carrying charges would be less both in this country and abroad. The value of the product of mills everywhere would be enhanced because of the higher price which would be received for that product on account of the lower freights on the offal. A satisfactory machine for this purpose has not as yet been devised. It is an open problem, but one which will certainly take practical form in the course of time. The packing of bran would be a great help to American millers, as would anything which would enable them to market their products at a higher cost than at present. Another way in which the packing of bran will help American millers will be that it will not only help them to get rid of their offal at better prices than they are now getting, but it will also make a better market for their flour in the countries to which it is exported. It is known that many of the mills abroad realize their only profit from the offal, and if we step in with our bran and mill feed we cut them out of this profit, and in that way cut down their milling capacity and make room for our own flour.

Broad, clean bran is an indication of good milling. It means clean flour and clean feed. If the bran is badly cut up, and is in small pieces, it is a fair indication that a dangerous proportion of it has been pulverized and distributed through various grades of the flour. Broad bran suggests that the grinding has been well done, that the break flour is clean and bright, that the middlings were easy to clean, and the bran easily finished on the last reduction. An examination of the bran is often a key to the whole grinding. It shows the whole thing at once.

While speaking of bran and feed, other matters pertaining thereto come to mind, but which are not associated with the above subject. It has been noticed that people in looking at bran would squeeze it and toss it up in their hand and say: "Well, what do you think this will weigh?" We are always compelled to say, "we don't know." But from motives of curiosity the trouble has been taken to ascertain. Those who would ask the question as to weight would have in mind the matter of yield; but the yield cannot be judged by the weight of the bran or feed. In experiments as suggested above, it was found that the bran weighed fifteen pounds to the bushel, and that the same bran could be cut up so that it would weigh thirty pounds to the bushel. This was done by running the same finished bran through a bran roll which was set up very close. Afterward the flour was sifted out and the bran weighed with the above result. The red dog feed, which was entirely red, with no signs

of flour, would weigh more after it was ground than before. It is quite clear that the weight of bran and feed does not signify much in regard to the yield. A still more convincing proof is that in one mill, where it is with difficulty that the desired weight of feed can be gotten into a car, the yield may be slightly higher than in another where the bulk is much less.

There are found in the market three kinds of offal—bran, fine feed or shorts, and finished or feed middlings. The fine feed or shorts contains very fine bran and red and woolly fibre, while the feed middlings are of a reddish gray color, and the richest feed from the mill. It contains bits of middlings, small pieces of nubby bran, that is, bran with a small portion of adhering middlings, and perhaps some flour. Now, it is these finished or feed middlings to which objection is made; they do not belong in the feed pile. There should be two kinds of feed. bran and red shorts, or fine bran. Anything which goes to make the feed middlings look white or gray can be made into flour that is worth more than the feed. If the feed is white or gray, that is a sure sign that there is flour, or flour making properties, in it. Some will say that if this kind of flour is run into low grade it will reduce it so low that it would be better policy to run it into the feed pile. All this flour would not be so low, though a part of it would. That part should be taken out and barreled by itself. If it is not desirable to put in a packer for this extra grade, it can be run into sacks and run out once or twice a week. The great waste of high yields comes from this grade of feed.

CHAPTER XV.

THE QUESTION OF YIELDS—BUHR AND ROLLER YIELDS COMPARED—YIELDS FROM CLEANED WHEAT—THE MACHINERY OF THE MILL LIMITS THE PRODUCTION OF CLEAN FLOUR AND CLEAN FEED IN THAT MILL—COMPARISONS OF YIELDS UNDER THE OLD AND THE NEW SYSTEMS—CALCULATIONS OF PERCENTAGES—YIELD AND PERCENTAGE CALCULATED TOGETHER.

The question of yields is an interesting one. Uncertainty and doubt on this question may well be called the skeleton in the miller's closet. An uncertainty in this matter is wearing and depressing. Many millers take a yield every day by weighing the feed and counting the flour. Estimating the invisible or unaccountable loss as eight pounds per barrel, if a miller were to make 6,600 pounds of feed and 100 barrels of flour, it would indicate that he took four bushels and thirty pounds of wheat to make 196 pounds of flour. The writer knows of at least one mill which is arranged to weigh the wheat before and after cleaning, and the feed at the end of each day. This, together with the packer registers, gives exact and reliable information. It appears to the writer that a miller could run such a mill with an easy conscience. He could be sure of himself every day. Such an arrangement would not only give the exact yield of flour and pounds of feed, but would also show the invisible loss from day to day and suggest means of reducing it. Automatic scales are used in some instances to take daily yields. How reliable they are cannot be said. A daily yield is a good thing to have. It locates responsibility. It points out the times of loss in such a way that they never can be of long duration where proper energy or skill is displayed.

The writer has made lower yields on a buhr mill than he was ever able to make on a roller mill. It has been said that the difference in yield between the two is a mere matter of detail; that is, by rolling far enough and often enough as low a yield can be made on rolls as on buhrs. However, the writer cannot agree with this statement. It appears that there is a limit to the profitable reduction of certain grades of stock by

smooth rolls; that, after being rolled a certain number of times, it reaches a state which is calculated to resent the smooth roller action. At this point millstones or scratch rolls become necessary.

One often meets this question as to which will make the best yield, rolls or stones. Rolls will make a better flour from a low grade of stock than buhrs, or as they can go further into the wheat and still maintain the difference in price between the flour and the feed, but it is evident that they will make the best yield up to the point mentioned; that is, they will put a larger portion of the wheat into a more valuable form than the stones. The fact that a miller does not make as good a yield on his gradual reduction mill as he did on his buhr mill does not prove anything. There was a controversy in a prominent milling paper a few months ago in regard to yields, which brought many millers with high yields to the front. Such yields as were talked about, from four bushels and forty pounds to four bushels and forty-eight pounds, are wasteful on winter wheat. A yield of four bushels and thirty pounds, on an average crop of wheat, counting it as it comes from the cars or wagons, should be the maximum per barrel.

Millers are not inclined to talk publicly about yields, more especially those made at or near the time at which they are speaking, though many are willing to indulge in a little reminiscence. There is no great difficulty in keeping roller yields as low as four bushels and thirty pounds per barrel. With buhr milling, previous to the change to rolls, there was no more difficulty in keeping below four bushels and twenty pounds, and the writer calls to mind yields which varied from four bushels and eleven pounds to four bushels and fifteen pounds. These figures are given for the purpose of making the comparison and illustrating the statements which are to follow. The difference between a yield of four bushels and twenty-four pounds and four bushels and thirty pounds is not so great as affecting the cost of the flour as it is often counted, as it may be entirely owing to a larger yield of low grade flour, and not to a proportional increase in the percentage of other grades. In such a case —that is, when the yield is made by the increase in the amount of low grade—the 4-24 yield would be better than the 4-30 yield only by the difference in amount and quality of the low grade flour. The output of high grades would play no part in the matter. The difference between the 4-11 and the 4-15 yields which were mentioned, was made entirely in the low grade flour. The absolute amount of high grade was not

changed, though the registers indicated that there was a smaller proportion.

Yields are sometimes calculated from cleaned wheat, but as wheat is not bought in that condition, that way cannot form a safe basis. There are limitations as to the yield of a mill arising from its arrangement. There are always points beyond which it is not safe to go in the endeavor to make flour at a low cost without corresponding changes in the amount and arrangement of the milling devices. Such arrangements limit the possibilities of the percentages and yield, and it is not safe to go beyond these limitations. In fact, it is sure to result in harm. In the effort to crowd a mill beyond its possibilities, low grade products must of necessity become mixed with high grade flour. In this way one may lose money by getting the yield too low, as well as by going to the other extreme. When a miller reaches the possibilities of his mill in producing high grade flour, he can only better his yield by an increased quantity of low grade, and there is a good chance to hurt something here, as it should be remembered that pulverized bran is not necessarily flour, even if it will go through No. 14 cloth.

There is no doubt but that under present methods, taking the whole country together, more wheat is being used to make a barrel of flour than with the stones. This does not argue that it takes more wheat by one system than it does by the other, but it does argue that the mills at large are very incomplete, and that a great deal of stock is run into the feed pile which might be run into the flour, and for two reasons: First, an insufficient number of reductions on all grades of stock, which means an insufficiency of machinery; and second, overcrowding the machinery in use and trying to get too much stock through the mill. There is hardly a mill in the country whose capacity is not overestimated or overworked. Mills which should not make over 75 or 100 barrels, are called 150-barrel mills, and very often crowded to that point. There are many mills labeled at 500 barrels capacity which cannot go above 400 without excessive waste; yet they are very seldom allowed to run down to that figure. A few trials and a little calculation will show the correctness of these statements.

Until a mill has a fixed grade, an exact quality of wheat to grind, it cannot have a fixed running capacity. Hard, dry wheat can be ground much more rapidly and at the same time finish the feed much better than soft, tough wheat. The character of the stock

going into the feed pile determines the quantity of the feed to be put on a mill, and by varying it on the same grades of stock, the difference in profits therein can be readily realized. The idea that it does not take more wheat to make a barrel of flour on the gradual reduction system than by the stone system is exemplified, as is believed, in the mills of Minneapolis. There the general principles were worked out early, and during the last months and years the details have been looked into carefully, and such additions made as to make the mills more nearly complete than in any other place in the country. No doubt there are as good mills outside of Minneapolis as there are in it, when considered with reference to the quality of the work, but it is fair to say that Minneapolis is representative of the best milling in this country. The right kind of men got hold of the business in the start, and, taking it altogether, the mills, the buildings, the workmanship and the quality of the help, there can be no doubt in the mind of any one as to the superiority and position of leadership which these mills and their millers occupy. These mills have been gradually reducing their yield for some time past, until it is now lower than it has been for years.

There was published at one time a statement that the mills of a certain city were averaging about four bushels and forty pounds of wheat to a barrel of flour. This is not mentioned with particular reference to that city, but merely as a statement which represents average yields. There was a time, no doubt, when they used less than this amount, but not since they have been using the roller system. In future it will no doubt be much lower. Instances have been known where the yield was mentioned on the basis of cleaned wheat, but this cannot be right, as the cleaning machinery is a part of the mill, and its work is included in the general milling operations, and anything which is taken out is as much a part of the offal as the bran or other feed.

After all, the calculation on percentages should be made with reference to the quantity of wheat used, and not the amount of flour packed. One miller may pack 35 per cent. of patent, as based on the packer registers, and another may make 30 per cent. on the same basis, and yet by making a lower yield the latter gets a better percentage of patent out of the wheat. That is, one man will make 30 per cent. of patent, as estimated by the registers, and throw a certain percentage into the feed-pile which is not registered, while another miller will barrel this waste and calculate his percentage accordingly. The calculation o

percentage, to be of value, should be associated directly with the yield. If a small percentage of low grade, or a large percentage of high grade, is indicated by the packer registers, it is significant of good milling only when taken in connection with the yield.

As said before, it is often the case that low yields are made by making a large percentage of low grade flour. The difference between a yield of four bushels and twenty-four pounds and four bushels and thirty pounds is not so great, as affecting the cost of the flour, as is accounted. The writer has seen the calculation carelessly made in this way, that the difference between 4.24 and 4.30 was six pounds, and that, with wheat at ninety cents a bushel, this would make a difference of nine cents in the cost of the flour. This is not correct, as it is entirely possible that this six pounds' difference may be in low grade flour, worth, say, a cent a pound; and then there would be added to the quantity of feed this six pounds which was lost in flour. With the feed at one-half cent a pound, there is three cents which is not lost. Instead of losing the wheat, which was nine cents worth of stock, we merely threw stock worth six cents into the feed, and then, as feed, we got three cents for it. Therefore we lose only three cents, instead of nine.

There should be means for taking a yield every day, and, at the same time, of determining percentages, which latter operation is commonly done in a very loose way. If a miller sits down in the evening and figures up that he has made 25 per cent. of patent and 65 per cent. of clear and 10 per cent of low grade, he may have reason to feel satisfied, or he may not. A calculation of percentages means nothing unless taken in connection with the yield. Millers have been known to go along for weeks at a time, priding themselves on the low grade flour which they were making. If that were the point, the miller mentioned above is making 10 per cent. of low grade, and might run enough of it into the feed pile so that he would be making 5 per cent., and on this latter basis feel contented.

It is hardly right to speak of yields and percentages in this distinguishing way; that is, using them in a way to indicate a wide difference of meaning, when in fact there may be a percentage of flour from the wheat, or the same idea may be expressed by speaking of the yield of flour from the wheat. It must be clear to all alike that the method outlined is in every way preferable to the one in common use. Of course

it is not possible to make a daily calculation of this kind in mills as commonly arranged.

When yields are taken in the regular way, it is suggested that the results be expressed in the way indicated below. As an illustration, the following figures are selected as expressing the percentages in the ordinary way: 25 per cent. for patent, 65 per cent. for clear, and 10 per cent. for low grade. Then a yield of four bushels and thirty pounds per barrel is assumed. Eight pounds represents the unaccountable loss. Thus there are 270 pounds of wheat, 196 pounds of flour and 8 pounds of invisible loss. This, expressed in the form of percentage, makes the following showing:

	Per cent.
For flour	72.5
For feed	24.4
For invisible loss	2.9
Total	99.8

To separate the different kinds of flour and make the same calculation this table is made:

	Per cent. of wheat.
Into patent flour	18.125
Into clear flour	47.125
Into low grade flour	7.250
Into feed	24.4
Invisible loss	2.9
Total	99.8

This shows the exact condition of things—yield, percentage and loss all taken into consideration in one calculation—and is the only way to put it and be exact.

After taking the yield in the ordinary way, the percentage of each kind of flour can be used to form this valuable and instructive combination. It will show many things which are not understood and appreciated. For instance, two or three yields expressed in this way will show just where the variation is effected. It may be that for one yield a lower exhibit in the amount of wheat used is made, at the same time a larger percentage of low grade is indicated, while the percentage of other grades may not be absolutely affected, though relatively they will be. This will indicate that the improvement in the proportion of flour to wheat, and the consequent decrease in the percentage of feed, is made entirely in low grade flour.

Fearing that this explanation may not be altogether clear, this idea will be expressed in another way. A miller may make a better yield as far as the amount of wheat is concerned by going a little farther into his feed, but without absolutely changing the amount of other flour made. Again, another calculation of this kind, at another time, might show that an improvement in the yield had been made by increasing the amount of patent flour made, and without changing the amount of other kinds. Furthermore, a comparison of a number of these tables might show where the percentage of wheat, feed and loss were the same, while the value of the yields were widely different, owing to the varying proportions of the different kinds of flour. Thus, while the main proportions might be the same, a larger proportion of patent and a corresponding decrease in the other grades would indicate the better yield.

An accurate knowledge of the percentages which would be given in the way shown would develop the weak points, or rather show the weak points, in the mill or the millers. There would be fewer opinions based on prejudice, and the exact value of every milling machine would ultimately be determined according to an incontrovertible standard. There is nothing known which is better for millers and mill owners alike than daily yields. It is believed that the time will come when such yields will be as common as the weighing of wheat now. The very profitable milling of several years ago developed careless habits in all these matters. There were millers who did not take a yield once a year; in fact did not know how much wheat they were taking at any time. Now that times are closer, there is less carelessness in this respect, there being few millers who do not have a tolerable knowledge of how much wheat they are using. As prosperous times made millers careless, the closer times will make them careful.

If one were to say that he meant, when using the word "yield," the amount of wheat used when making a barrel of flour, he would cover the ordinary idea on this subject. But there is a broader definition of the word as applied to milling. It means money, after all, and the mill which yields the most money per bushel of wheat is doing the best work. It does not necessarily follow that he who is making a barrel of flour out of the least wheat is making the most money. It is entirely possible to make 196 pounds of stock which will go through a flour cloth out of, say, 210 or 212 pounds of wheat; that is, making this allowance of from fourteen to sixteen pounds for loss which cannot be accounted for, and

perhaps a little feed. Now, it should be remembered that the fact of stock having gone through a No. 12 or 14 flour cloth, does not imply that if a miller were to put so large a proportion of his wheat into the flour packer as is above indicated, he would be doing the best possible thing in the way of a yield, for the reason that the miller who is making proper a more intelligent separation by running that which may be called flour into the flour packers, and that which is properly feed into the feed bin, is making the best yield, in that he will get more money out of his wheat.

CHAPTER XVI.

UNIFORMITY OF FLOUR AS A VALUE GIVING ELEMENT—THE EFFECTS OF WHEAT ON THE UNIFORMITY OF FLOUR—REDUCTION OF HARD AND SOFT WHEAT—THE SIZE OF WHEAT—THE MOST THAT A MILLER CAN DO FOR HIS FLOUR—WHEAT HEATERS AS CONTRIBUTING TO UNIFORMITY—SMOOTH ROLL REDUCTIONS—SIZING ROLLS.

Any one who knows anything about the sale of flour knows that the flour made by a miller who has the reputation of making a uniform grade as to quality will command a price based on this uniformity as well as on its actual value. A flour may not be exactly the best flour which goes to a certain market, yet it may command the best price, or a price above that of flours of similar but uncertain quality. The view taken of this matter will not be a trade view, only in so far as anything which pertains to the manufacture of flour has to do with the trade. It is a manufacturing view. There are many things—many conditions—which may alter the grade and alter the uniformity of the same.

First and foremost there is the wheat, and it may be said that wheat has a myriad of sins on its shoulders which do not belong there. It sometimes happens that a miller neglects his mill during the night and there is bad flour in the morning, and it sometimes happens that he says that the wheat is to blame. When reports come from the East that the flour is working badly, the wheat is often blamed.

A miller cannot always have a uniform grade of wheat, even if it be of the same general variety. It has been said that if the miller always had a uniform grade of wheat and if the laces did not break, if the grinding did not require changes, he would be paid the same as a roustabout. It is the business of the miller to make such changes in his mill as to its running, its grinding and bolting, as are suggested by the size, texture and characteristics of the wheat. With soft wheat it is often required that the grinding be closer on the first and second breaks and rather open on the third, fourth and fifth. This will make round, sharp mid-

dlings. On the other hand, with hard wheat, the grinding may be more open on the first break, and in event of the bran being dirty, the same relatively high grinding may be preserved to the last.

Soft wheat will require more cloth and coarser cloth than hard wheat. Soft wheat flour may have larger granules than that from hard wheat and yet not be so sharp in feeling. Flour bolted through a 9 or 10 cloth where the wheat is soft will not feel as sharp as when bolted through a 12 or 13 cloth with hard wheat. For this reason it is important that the bolting apparatus be so arranged that the flour may be taken, in whole or in part, through fine or coarse cloth, as circumstances may suggest. There are two ways of doing this. The coarse cloth may be at the head, as is usual, and the finer cloth below, by which means all material going through the coarse cloth may be re-bolted below; or this same arrangement, as to the coarseness of the cloth, may be reversed, and the last or bottom reel may be clothed with coarse cloth. For such an arrangement the reels above should each be clothed at the tail with scalpers of increasing fineness, which will bring the material to be bolted on the last reel or reels of a quality to be readily converted into clean, bright, sharp flour.

There will be times when the wheat is very hard that this will not be used at all, but it is not necessary that the flour should be bolted through a uniform cloth to be uniform in feeling as to its sharpness. The sharpness of flour is determined as much by its hardness as by its size. The granules may be large and soft and yet not feel sharp, or they may be hard and small and yet possess all of the granular elements of good flour.

Hard wheat, of course, makes more middlings than soft wheat; yet the effort to make a uniform proportion in either case will be in the direction of uniform work. The same grinding which will make round, sharp middlings out of hard wheat, will make soft, clammy, flat middlings out of soft wheat, and middlings which cannot be purified. With hard wheat the reductions can be more uniform in the amount of work done from the first to the last break. With soft wheat a larger proportion of the work of reduction must be done on the first two or three breaks, more particularly the first two, which, followed by higher grinding, will make large, round middlings, with clean bran on the last break, together with distinct separations of the branny from the floury portions of the wheat.

The size of wheat exerts a marked influence in the operation of the mill. A change from large to small wheat of the same quality and variety, as often happens, will largely increase the feed on the mill, and give relatively higher grinding, which would work a marked influence on the separations. On the other hand, the change from small to large wheat cuts down the feed and makes the grinding relatively closer, and whereas the stock on the reels may not be so heavy, it is quite soft. The change in grinding may not be so disastrous to the break flour as to the middlings and middlings flour, which are small in volume and soft in character. Thus such changes in the wheat require corresponding changes in the grinding to maintain uniformity in the product.

No miller can battle against unsound wheat; therefore it is somebody's business to keep unsound wheat out of the mill. Carelessness in this respect demoralizes the interest of the help. The miller cannot and will not take an interest in his milling when, in the midst of smooth sailing, he is liable to run against a car of unsound wheat. A uniformity of flour cannot be preserved with widely varying grades of wheat of the same variety, yet the proportionate difference is not the same by any means. There may be a wide variance as to the texture, and for all marketable purposes no marketable difference. The methods for reaching such a result were shadowed in the above suggestions.

On general principles, all that a miller can do for his milling is to maintain an even granulation of products of uniform brightness. If a flour is bright and granular, that is all a miller can do for it. He cannot impart strength which is not in the stock. After all is said and done, the most skillful grinding and manipulation can give only an approximately even granulation. This lack of uniformity can be partially reconciled by the subsequent smooth roll reductions and sizings, separations and purifications.

With reference to the uniformity of products, it is proper to speak of the wheat heaters. They contribute largely to the uniformity of the character of the wheat, and they are wonderful in their ability to maintain a uniformity in the color of the flour.

Having mentioned the breaks and canvassed the first operations on the wheat, more remains to be said in regard to separations. No reduction system or system of grinding, no matter how well the grinding may be done, can atone for the deficiencies of the separating system. The reductions are important, and good grinding is necessary, but they

cannot be so complete as to override deficiencies in the bolting and purifying.

In regard to the smooth roll reductions, there are very few mills of any class where most of the smooth rolls are not overworked, and in many mills they are not used for grinding, but rather for mashing. The smooth iron rolls should never be run so close as to flake the stock. Where it is flaked the work is mashing and not grinding. In the reduction of any grade of material, such a reduction should only be carried as far as sizing and breaking, but not mashing or flattening.

Where the grinding is done as suggested, there is a margin of sharpness, a difference in granulation which will admit of variations according to the quality or consistency of the material handled, thus admitting of wide changes or differences in the quality of the product. The material to be ground or sized can be touched lighter—ground higher—when it is from soft wheat, and at the same time bolt cleaner and whiter than if it were from hard wheat. Hard wheat can be ground closer and still not flake. For this reason mills which are continually operating on soft wheat require more rolls and more reductions than those which are operating on hard wheat. On the other hand, the capacity of the mill cannot be so great when grinding soft wheat as hard. Unless the grinding is properly done in the first place, there can be no proper variations according to the material handled. The grinding has to be correct for one quality of stock in order to be incorrect and require changes for another.

Sizing rolls proper, that is, those which are used for breaking down the large middlings, require the greatest care and the most delicate manipulation of any of the machinery in the mill. The difference in quality and quantity of the stock is more marked here than at any other place. Furthermore, the middlings from the sizing rolls are of the highest grade, and any deficiencies there mark the entire product of middlings flour. As is well known, the reduction of the amount of feed on these rolls without a corresponding change in the set of the rolls themselves will make the grinding closer, and *vice versa*; and of course if it is right for one it is wrong for another. If the middlings are sized too closely they will be flat and soft, and if not close enough the product will be red and ragged and the tailings rich. Millers have more to learn about the sizing of the middlings than anything which is to be met at this time.

CHAPTER XVII.

THE DIFFERENT CLASSES OF REDUCTIONS—A GENERAL CONSIDERATION OF THE VARIOUS BREAKS—REDUCTION FOR MIDDLINGS PURIFICATION—DISINTEGRATORS ANTAGONISTIC TO GOOD REDUCTIONS—RELATIVE SEVERITY OF VARIOUS REDUCTION MACHINES.

According to present methods there are four classes of reductions—one for middlings making, one for middlings purification, one for middlings reduction, and a fourth for the cleaning of feed. In speaking of the first class, which refers to middlings making, it may be said that this reduction is made with reference to purification in the first place, and to clean offal in the second. It so happens that these two conditions are not antagonistic, as the same grinding which will make round, sharp middlings and those which are reasonably free from bran and other impurities, will leave the bran proper in a condition to be readily cleaned. That is, it will be broad and flat, which is the best possible condition from which to get the best flour and the cleanest feed. Being in large flakes, it is not so liable to be cut up and pulverized in the final reduction as when it is ground fine in the previous process of grinding.

The kind of grinding which makes this desirable bran stock, also brings the middlings into the best condition for purification, as suggested before. One way of reaching this result may be outlined by an analysis of the different breaks.

There is much less flour made on the first break than is generally supposed. The writer's experience with winter wheat is that the amount of flour on this break is not proportionate to the closeness of the grinding. One may set these rolls where he thinks they are doing proper work, and if, for any reason, he sees fit to set them closer, the amount of flour will not be increased in proportion to their closeness. This is because of the coarse corrugations, the size and quality of the product bearing a certain relation to the size of the corrugations. For instance, a set of rollers with twenty-four corrugations will make a larger proportion of flour and fine middlings than rolls with eight or twelve or other coarser corrugations, even though the stock be the same size. The

spacing of the corrugations, to a certain extent, therefore, influences or regulates the proportion of fine products of the reduction.

The second break more seriously commences the work of middlings making, though this, as well as the first, is more of a preparatory process than otherwise, each doing its work of sizing and opening the grain for the subsequent reductions.

The first break is more of a direct purification method than the following wheat breaks, in that a proportion of deleterious material is removed directly after this break. The second break makes large, coarse middlings and a small proportion of flour. The grinding on these two breaks has more to do with the ultimate condition of the bran stock and the quality of the middlings than do the three following breaks, the two former acting more directly in the preparation of such stock. If the wheat is soft, the first two breaks can be run closer, and the three following breaks more open than when the wheat is harder. The reason for this is that close work at first on the hard wheat breaks and shatters the bran more than it does when the wheat is softer and the bran tougher. The kind of grinding which makes the best middlings with either kind of wheat, makes the best bran stock. Closer grinding at first on the soft wheat admits of more open grinding on the third, fourth and fifth reductions. This makes desirable middlings, which have a very small proportion of detached or adhering bran. The more open grinding on the first two breaks on hard wheat may require a little closer grinding on the subsequent reductions in order to reach the desired end.

The products of the third and fourth breaks are near enough alike to admit of treating them together. The fourth is really a repetition of the third, though, of course, the product must be slightly lower in quality and smaller in size, proportionate to the difference in the grinding and the corrugation of the rolls. The similarity is that the stock is more nearly of the same class than that of any of the other reductions. It is here that the best and largest proportion of middlings is made and flour next to the purest.

The fifth reduction is decidedly on the downward grade. The middlings are small in size, the flour white enough, but accompanying this product before the separations are made, is a large proportion of long, hairy looking bran. It is on this break that the bad work which came before it shows up, in the production of this dangerous woolly stock.

The sixth break, which is most commonly the finishing process, can not be very bad with ordinary care, when the stock has been properly prepared for it. There are no middlings from this break worthy of being handled on purifiers. The flour from this break shows very red and dull in the dough, but makes comparatively a better appearance in the dust. This flour is too good to go in with the red dog, and when the feed therefrom is properly cleaned, it is not good enough for the bakers' or clear flour. It will grade, even when the bran is properly cleaned, equal to a St. Louis XXX, or a good New York Super. Therefore, the only thing to do with this grade of flour is to run it by itself or with flour of corresponding grades from the lower smooth roll reductions.

It is common to run the second, third, fourth and fifth break products together. This is necessary in small mills, but is not conducive to the best results.

The second class of reductions mentioned was for the purpose of purification. The products of the process of middlings making are middlings, flour and bran of various degrees of purity. After the bran is disposed of, there are the middlings, the flour, and the contained impurities. The flour being disposed of, all that remains is middlings, more or less pure. There are many grades which contain such a large proportion of deleterious matter that the ordinary purifier cannot appreciably help them. It appears somewhat out of place to speak of some of the lower roll stocks as middlings, yet they are neither bran nor flour. They are too rich for the former and too large for the latter. Such stock is really a low grade of middlings.

The smooth rolls and the separations which follow is one method of purification which belongs in this classification. Such rolls are, more often than otherwise, looked upon and used more as reduction agencies than as methods of purification. The smooth rolls are very important and useful in the purification of the larger grades of middlings. They are not appreciated for such use, but when it comes to handling middlings which we do not think it worth while to put on a purifier, their work is invaluable. They are the only machines which will appreciably aid in purifying this grade of stock.

While on this point it is well to say something about detachers and disintegrators, which are frequently used to follow the smooth roll reductions for the purpose of shaking up or detaching the smooth roll

stock. This is one thing which a miller does not want to do. The material goes on to the rolls for the purpose of making a separation, for purifying the stock, which allows it to be readily separated from the unbroken impurities. In some instances the impurities are flattened at the same time that the middlings are broken, and thus the separation is more distinct and marked. A detacher which breaks and tears to pieces the impurities, renders purification impossible. And whereas the rolls are efficient in purification without the disintegrator, they are mere reduction machines with it. The disintegrators are mixers, and spoil all the good work of the roll. Their use is often thought to be necessary on account of the stock being flaky, but this is no excuse at all, as the flakes are wrong in themselves. There is no reason why the reduction should be so close as to make the stock flaky. Smooth rolls should be used for breaking or sizing, and not for grinding or mashing. The flour cannot be clean or bright where the stock is squeezed and the impurities thus pulverized. Often when stock from smooth rolls looks foxy, the miller will try to bring up the flour by shortening up on the flour conveyor, which throws over a lot of soft stock to the next reduction and separation, and at the same time does the flour little or no good. If, under such circumstances, he should merely grind a little more open, he would find the flour bright and sharp, the tail thin and poor, and the cut-off sharper and cleaner, thus giving the following rolls less to do.

The work of purification is brought about in the larger middlings not only by changing the relative size of the pure middlings and the impurities, but by changing the relative specific gravity of the two parts, as well as by making a positive separation of the impurities from the middlings to which they are directly attached.

Of the different classes of reductions mentioned, the third was with reference to the reduction of middlings to flour. In either of the classes of reductions mentioned, the flour is made incidentally. The making of flour in the middlings making is what the miller does not want to do, as it goes into lower grades and commands a smaller price than when retained in the form of middlings for purification, and their ultimate reduction to pure flour here implied. The reduction to flour may be by smooth iron rolls, porcelain rolls, scratch rolls or millstones. The question of the relative efficiency of each is a mooted one. The severity of the reductions are represented on one extreme by the mill-

stone as being the most severe, and on the other by the smooth iron roll as being the most gentle, the porcelain and scratch rolls occupying intermediate positions, the latter coming next to the millstones in severity. In order to reach the same result, that is, the same quality of flour by the various reduction methods, the middlings have to be differently prepared for each. For instance, the millstones would do the best work when the middlings are of a small, uniform size.

CHAPTER XVIII.

THE CLOTHING FOR SCALPERS—THE RELATION OF THE CORRUGATIONS TO THE SCALPING NUMBERS—THE DEVELOPMENT OF THE PROPER SCALPING NUMBERS FOR THE VARIOUS BREAKS—THE PROPER STOCK TO TAKE THROUGH THE SCALPING CLOTH ON THE BREAKS—FINER CORRUGATIONS ON SMALL MILLS—LENGTH OF SCALPERS FOR VARIOUS BREAKS.

We all know that the clothing of the scalpers begins by making the first one the coarsest and the last the finest, with intermediate gradations. This is made necessary, in the first place, by the size and character of the material to be reduced, and secondly, by the size of the corrugations which perform these reductions. As to the size of the grain, it is easy to see that the largest middlings can be taken from the whole grains or from large parts thereof which include the full thickness or size of the inside of the wheat berry. For example, larger middlings can be taken from a whole or a half grain of wheat than from the material going to the fifth or sixth break, which contains only a small proportion of middlings stock. Thus the largest middlings will naturally be taken from the largest stock, or from stock which contains the material from which middlings are made in the largest sized pieces. In the second place was mentioned the size of the corrugations as influencing the numbers of cloth on the scalping reels. No one can intelligently determine these numbers without knowing the corrugations to be used for the various breaks. The stock being of the right character for the various breaks, the size of the corrugations will determine, to a large extent, the size of the middlings. For instance, if one were to use finely corrugated rolls for the first break, not nearly so large a proportion of large middlings could be made as with the coarser corrugations; and, as there is an abundance of stock out of which to make large middlings on the first break, it is fitting that the corrugations should be coarse, which implies that the scalping wire should correspond in mesh to the size of the middlings made. As the stock gets lighter, as the proportion of middlings on the wire decreases, proportionately finer corrugations are required. These two conditions together—that is, of

the stock and corrugations—imply that there will be finer middlings; and as they are finer, the scalping numbers will naturally correspond.

It should always be understood that it is desirable to remove such middlings from the various breaks as have no adhering particles of bran, and as such possibilities are indicated by the conditions named above, the scalping numbers should be arranged with reference t › such a result. Where they are too coarse it means that there is material to be handled on smooth rolls which could be more advantageously broken on the breaks following those from which such middlings were taken. Where such middlings are sized or reduced on the smooth rolls, it further implies that there is a large amount of coarse, branny material to be carried through the tailings rolls and subsequent reductions, which renders the work of finishing this material and the finer stock carried along with it much more difficult than it otherwise would be. Thus the advantage of arranging the scalping cloths so that the product of middlings will contain a minimum quantity with adhering portions of bran, is apparent. At the same time it is desirable that such clothing should be coarse enough so that the entire product of desirable middlings may pass through the cloth rather than over the tail and to the next reduction.

In the small roller mills which are now being built, which use only four or five breaks, the clothing of the scalping reels is finer as the corrugations are smaller and the grinding relatively closer. Furthermore, it is not desirable to have to handle large middlings in such mills as these, because everything being cut close as to the cost of the plant, there is not enough reduction and separating machinery to do full justice to larger middlings. For this reason in such mills the corrugations should be finer, with the intention of effecting the purpose above named; consequently the scalping reels would have finer wire or cloth.

Another thing affecting the clothing of scalping reels is the character of the wheat that is ground. Soft wheat will make larger middlings than hard, brittle wheat, and large wheat will make larger middlings than small wheat, which otherwise has the same general characteristics.

In connection with the breaks it will not be out of place to mention scalping reels, as a proper scalping is necessary for good reductions. The reels should increase in length or capacity as the breaks advance It is almost as important that they should not be too long, as it is that they should be long enough. When they are longer than is necessary

to make the separation of flour and middlings from the coarser material, they make flour in the reel and force fine bran and other deleterious material through the wire cloth. If the reels are too short they carry over flour and middlings, which is wrong in itself, in that it reduces the middlings at an improper stage in the process, while the flour is carried, it may be, into grades where it does not belong. Again, the unreduced portions cannot be properly handled when mixed with material not requiring reduction. The following lengths of reels have been found to be satisfactory in a 400-barrel mill, viz.: First break, 6 feet; second, 8 feet; third, 10 feet; fourth, 12 feet; fifth, 14 feet. For the sixth break a common form of centrifugal reel six feet long may be used, clothed with 20 wire, the tailings of which reel go to the bran bin, while the product is again scalped on an 18-foot silk reel, where it is graded into three grades.

CHAPTER XIX.

SMOOTH ROLLS—SMOOTH ROLLS AS PURIFIERS—SMOOTH ROLLS AS REDUCTION MACHINES—THE PROPER SETTING OF SMOOTH ROLLS—THE THEORY OF DIFFERENTIAL MOTION EXPLAINED—THE EVILS OF EXCESSIVE PRESSURE BY SMOOTH ROLLS—THE EFFECT OF DIFFERENTIAL MOTION IN PRACTICE—THE EFFECT OF VARIATION IN DIFFERENTIAL MOTION—THE SETTING OF SMOOTH ROLLS TO REACH THE BEST RESULT—THE LIMIT OF THE REDUCTION POWER OF SMOOTH ROLLS—THE NECESSITY FOR MILLSTONES OR SCRATCH ROLLS.

Smooth chilled iron rolls came into use in this country after the time of the introduction of the purifier. The value of smooth rolls lies in the fact that they are purifiers at the same time that they are reduction machines. They are the only reduction machines which will lend aid to the purification of the stock at the same time that their tendency is to reduce it. They reduce the flour portion, the portion which should be reduced, and at the same time flatten the germ and do not seriously disturb or disintegrate the bran, the fibre or other impurities.

The perfection of this idea is the perfect reduction machine. However, the smooth rolls are not perfect; they are not absolute purifiers. They approach more nearly the state of perfection as reduction machines than do any other milling devices of this kind.

The purification of middlings is not possible without the use of these machines. There are the large portions of wheat with adhering portions of bran, the pieces of middlings which cannot be removed from the bran on account of there being little or no difference in the specific gravity of the two products; then there is the fibre and the germ. The flour particles are easily disintegrated, and the bran and the germ and fibre are either flattened out, or remain undisturbed. There is a change made in the relative gravity of certain of the particles, and a change in the relative size of certain other particles.

In the first instance, there is a change of relative gravity by the breaking of the middlings into small particles, while the bran particles remain the same size, and consequently of greater gravity than the

middlings themselves. Then again, the change as to size is more clearly illustrated by the breaking of the middlings and the flattening of the germ. Not only are the middlings made smaller by the breaking, but the germ is made larger by flattening. All separations by smooth rolls are made on account of the relative size of the pure or impure particles, and their use must be considered with reference to bringing about such a change. The idea that they are mere reduction machines and not purifiers, limits their usefulness.

A miller who buys a reduction machine merely for reduction purposes, need not waste his money by buying smooth rolls; he can get more reduction per dollar by buying millstones or scratch rolls.

New process and gradual reduction milling came about as the development of purification ideas, and the development of new process and gradual reduction machines has been in the line of purification. The miller reduces to purify, and he purifies that he may reduce further. Now, if he may reduce and purify in the same operation, he is following out the true principles of his business. Such a thing is possible with the use of the smooth rolls; that is, when properly used.

Absolute perfection and absolute purification is out of the question. There is no perfection, and there is no such thing as absolute purity. An agent of purification can only hope to make approaches toward perfection. No one machine can do it all, and no one or no class of machines can reach the limit of present possibilities.

When we say that a smooth roll will purify, we mean in fact that it will help, that it will lend aid as a purifier, and we speak of the ordinary sieve and suction machine in the same sense—as a link in a chain, as a part of a process. If the miller has in mind that his smooth rolls are purifiers and will treat them as such, he will do better work with them, will handle them altogether differently than if he were using them as reduction machines.

The miller who sets a pair of smooth rolls with a monkey wrench does not know that they are purifiers, neither does he who lets them run by friction with tight springs. The miller who allows the stock to come through the rolls in a flaky condition is not aware that the smooth rolls are purifiers. They perform this valuable office only when used carefully and intelligently. Absolute pressure on the stock does not reduce it, does not disintegrate it. It merely flattens it, hardens it.

"Pressure will disintegrate only to a certain extent, beyond which it

produces increased solidity. It is therefore erroneous to suppose that middlings which are to be reduced by rolls should be subjected to great pressure. Neither is it true that pressure will hold the middlings against both rolls, as is necessary to effect the desired end."—[*Dr. Sellnick.*]

The same authority says in regard to the differential velocity of rolls: "The term differential velocity does not relate to the varying velocity of the revolution of the rolls, but is derived from the differential velocity of the circumference." By this is meant that two rolls of different size may run at different speeds and still not have a differential velocity. Say we take a roll which is thirty inches in circumference, that is a little over nine inches in diameter, and run it against another roll which is twenty inches in circumference, or a little over six inches in diameter. Now, the larger roll might run 300 revolutions per minute and the smaller roll 450 revolutions per minute, still they would both travel the same number of feet as measured by the velocity of the circumference. Both would travel 9,000 inches per minute, which result is derived by multiplying the circumference by the number of revolutions per minute. Differential velocity means an absolute difference in the number of feet traveled by the circumference of two rolls in the same length of time.

Here is a cut of a drawing made by Dr. Sellnick wherein he illustrates the theory of differential motion. *A* is the slow roll, and *B* the fast roll; *b* will arrrive at b' while *a* is at a' and *a* arrives at *x* (a'') and *b* will be far beyond at b''. All points *b* move with greater velocity than points *a*. Fig. 2 represents the action of differential motion on an elastic substance. The body will be held at *a b*, and in its passage to a'' b'' (when *a* arrives at *x* and while *b* has arrived at b'') it must stretch the distance a'' b'' and form a band-like strip (a'' b'') in length. In the case of brittle particles the substance would be broken into small pieces. If there be no differential there will be mere compression and incidental integration.

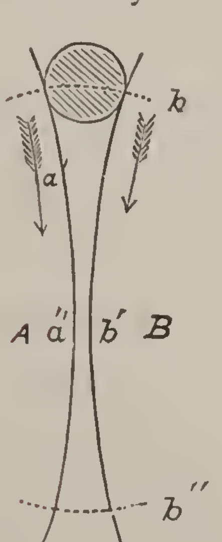


Fig. 1.

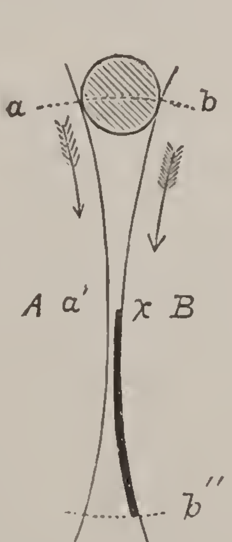


Fig. 2.

Dr. Sellnick tells how stock may be calendered, that is, polished, made smooth and hard like a sheet of paper. Calendered paper is produced

by differential motion, one roll running slow and the other running fast as to its circumferential velocity while the paper is held under great pressure. This makes a smoothing action—a compressing, polishing action. This is what the miller does when he sets his rolls very close and makes a hard, flaky stock. He has calendered middlings or calendered tailings, or even calendered red-dog. He has a sleek, glazed, compressed mass, and then he runs the stock through a mixing machine called a disintegrator, and pulverizes and tears to pieces the wafer-like stock in a way to derive no benefit from a smooth roll reduction. The impurities and all alike pass through the cloth and go into the flour and reduce the price. Either reduce the profits or increase the loss to the mill owner.

Smooth rolls to be run properly should be set for a breaking or disintegrating action. They should not be allowed to compress the stock. The distance between one roller and the other should be such as to reduce the size of the brittle particles and merely flatten to a slight extent the germ particles, but not necessarily disturb or compress the bran particles. If the latter has adhering particles of middlings the action should be such as to break the flour particles because of the differential motion, but there should not be a pressure such as to flatten the middlings particles, or to break and disintegrate the bran particles.

After stock has been once compressed it can never again be reduced without disturbing and pulverizing the impurities, for which reason we may say that many smooth rolls are improperly handled.

Quite a difference may be made in the product of the tailings rolls by a change in the differential motion of such rolls. While the differential is excessive the flour will be more ragged, it will feel longer, and will contain a larger proportion of deleterious material than when the reductions of such stock are made with a smaller proportion of differential. The action of the differential motion of smooth rolls is to elongate the stock. This quality or tendency is limited by the liability of the stock to break. If a piece of dough were passed through the smooth rolls it would be flattened out, or elongated. The amount or proportion of elongation would be estimated by the differential motion of such rolls. The tendency of one roll to hold back and of the other to advance may be estimated by the excess of speed of one roll over another, and the elongating qualities on such a movement are exactly in proportion as the difference in speed. It is evident that the break-

ing action will predominate; that is, there will be more breaking than elongation in flour stock. There cannot be much elongation of middlings or brittle material of that kind. It will be broken. There is a limit to the elongating qualities of all material which goes on rolls, whether it be impurities or otherwise. Where the differential is excessive, it is apparent that a certain large proportion of the impurities would be broken and pulverized by the differential action of the rolls. As an illustration of possibilities, we will say that the motion of the rolls be integral; that is, that there be no difference in speed. There will be a compressing of the stock, and certain portions of it will be broken. There will be very little of the pulverizing action, either of legitimate flour or of impurities. The flour stock will be incidentally pulverized and broken, and the impurities, which are usually of a tougher character than the better material, will not be appreciably disturbed.

It is the tendency of all millers to want to pulverize or to make flour on most reductions, and especially the tailings and the lower grade rolls, and for this reason it may be expected that there will be a certain amount of differential at times in the reduction of this material. In fact, it can hardly be expected, nor is it desirable, that there should not be differential motion wherever smooth rolls are used. The disintegrating action of this movement is so gentle when the rolls are not set closely together that it cannot but be desirable, though the amount of such differential may be varied according to the quality of material to be handled. With belt rolls it is a very simple matter to vary the movement, and it will be easy for any miller to demonstrate to his own satisfaction the proper motion to select in the reduction of various kinds of stock. There is a disposition among many who handle these rolls to set them very close, which is entirely wrong, principally because it does not accomplish the desired end. There is a lurking idea in the minds of many millers that the closer the rolls are set, the closer it is possible to set them and still keep the belt from slipping, the greater will be the amount of work done by such rolls. This is wrong.

There is a proper point, there is a point in the setting of rolls which will accomplish more work than any other, and it is not the point where the greatest amount of power is consumed or where the rolls are set the tightest. It is where the stock is broken and not flattened. This is the greatest evil, the place where the greatest wrong is done to the stock in milling—this same close setting of the smooth rolls. It is a very simple

matter to judge when the rolls are doing their proper work. The stock, as it comes from them, feels as though it had been ground and not mashed. Not only will the amount of flour made by the proper setting of the rolls be greater, and not only will the proportion of pulverized impurities be less, but the amount of power will be greatly less. A miller says to himself: "I have only a few pairs of smooth rolls. I have not enough; therefore I must set these rolls very tight, that I may hasten the operation of reduction." He does not do anything of the kind; he cakes and hardens the stock; he makes it impossible to reduce this stock on anything short of a millstone. Having been treated by one set of rolls, those following have very little effect in hastening the work of reduction.

The writer remembers to have heard a very forcible illustration of the reducing power of smooth rolls. It was by a Hungarian miller. He had been working in a mill where there were two pairs of smooth rolls, some three or four reels, four or five purifiers with adjustable sieves, and one or two pairs of millstones. All the work of the mill was done on this machinery. One or two reductions at a time were made on the rolls that were in the mill, they being adjusted for each class of material to be handled, while the middlings and bran were reduced in their proper order on the millstones. It was the habit of the head miller of this mill to reduce all of his middlings on stones, and the miller referred to said to him at one time: "Why do you not reduce your middlings on these smooth rolls?" Said the head miller: "We do reduce them as far as we can. We reduce them to dust middlings (fine middlings) on the smooth rolls, but we cannot reduce them farther by such means." The Hungarian replied: "It is my watch to-night, and if I may, I will try," and with the consent of his superior he did try. There was an accumulation of some ten barrels of this stock which had been produced by the breaking down of the larger middlings. He commenced to run it through the rolls, having it carried there by the help, and from the rolls to the reels. He reduced very carefully and very gently and got very nice flour. He had the middlings carried back to the rolls and passed through them again, with the same result—very nice flour. The third and fourth time was this repeated. Then he had about four barrels of stock remaining. After this the smooth rolls were almost entirely inoperative. The stock kept going around and around without producing flour. He had been very careful; he had reduced the material very gently,

only a little at a time, yet after four or five reductions on middlings which had passed through a No. 6 cloth, say, very little flour could be made.

This illustration meant a great deal. It showed or rather confirmed the belief that a complete corrugated and smooth roller mill is not quite the thing. It is hardly possible to completely reduce the product of the corrugated rolls with the smooth rolls. These rolls will go only so far, however carefully they may be handled, and no farther. There will be a certain amount of stock of most excellent character which is tailing over to the red-dog, and if the red-dog rolls be smooth iron, they will be tailing over the feed. In the case referred to by the Hungarian miller, he said that after he had reduced the stock five or six times or more, and found that little or nothing was being done on the last two or three reductions, he had it carried to the millstones and there reduced. As the material had been scalped repeatedly during the process of this reduction by smooth rolls, it was well purified, and was for this reason in good condition to be handled by the millstones. It made most excellent flour, of a very high grade. After all, the use of the smooth rolls in this way was not without its beneficial results. Smooth rolls, properly used, are always purifiers. In behalf of the millstone idea for the purpose of reducing certain grades of stock in a roller mill, we may call to mind the fact that more millstones are used by Hungarian millers in proportion to the amount of flour made, than by the best American millers. Millstones are more necessary in aiding in the reducing of soft than of hard wheat.

The condition of things as here shown is what makes it so difficult to carry out the full roller mill idea. After the stock has been submitted to a certain number of smooth roll operations, it is in a condition to effectively resist farther successful operations. It becomes hardened, or, as previously expressed, calendered. There can be no doubt but that millstones or scratch rolls are necessary to carry out in an economical manner, the desired purposes and results of gradual reduction milling. In the case of fine middlings, which are well purified and which have been made fine during a series of roller reductions, nothing better can be done with reference to the ultimate result, yield and all being considered, than to make a reduction by millstones. After the stock has been hardened or flattened by smooth rolls, the reduction by millstones will again bring it into a condition where it may again be reduced by smooth rolls, for which reason the stock may be farther purified in

the handling by the gentler methods of reduction at a time when a different purification is necessary. To illustrate: Say that we have pure middlings, or, to say the least, middlings as pure as we can get them, we then reduce them twice, perhaps, by the millstones, after which they are in a condition, even though they are somewhat hardened by previous smooth roll reductions, to be again handled by smooth rolls. Furthermore, this material is in a condition, after leaving the millstones, to need farther purification.

CHAPTER XX.

OVERGRINDING—THE PROPORTIONING OF THE VARIOUS PARTS OF A MILL—PRACTICE DEVELOPS A FORMULA—THE REDUCTION SURFACES OF A GRADUAL REDUCTION MILL.

We all remember how much we used to read and talk about overgrinding, and how we all agreed that from five to seven and eight bushels an hour was quite enough for a 4-foot buhr; and most millers practiced what they preached. The same subject in regard to feed of rolls has now come around to general discussion. To be sure, there is not the same danger from overheating that there is with buhrs, but there are many other evils attending overgrinding by the latter methods of reduction, some of which are the same as from overgrinding on buhrs, and others which are distinct therefrom.

Where the roll has too heavy a feed the yield of middlings from the wheat cannot be so large as under more favorable conditions. With a heavy feed the product of the roll takes more of the nature of a conglomerate. The flour and middlings are forced into the particles of wheat rather than separated from them, as they would be with a lighter feed. In this way the separating machinery, or subsequent reduction machinery, cannot do its work so well as it should. The deleterious material from the wheat will be more intimately mixed with the desirable middlings or flour portions. The former will be soft and flat. The bran will be lumpy and unevenly cleaned. There will be a part of it that is cut up as fine as sawdust, another that is clean, and the remainder which is rich and unfinished. Where there is this kind of bran—that is, unevenly finished—it shows that that part of it which is overfinished—cut up—must have been cleaned or finished on a previous reduction, and the product of low grade material, which naturally belonged in the last reduction, went in with a higher grade of flour of the other reductions. On the other hand, the lumpy and unfinished bran indicates that there were higher grades of stock taken from it at the last reduction or reductions than naturally belonged there. All this may be the result of overgrinding, which means carrying too heavy a feed.

The only way to make uniformly broad, clean bran is to have the grinding surface properly proportioned throughout, and not to feed any heavier than will bring about the best general results in the grinding.

The evils of overgrinding apply to smooth roll reductions as well as to those by corrugated rolls. A writer has said: "If we have two rollers working together of the same diameter, and made of some hard material, they will seize and crush and squeeze the grain which is to pass through as soon as their distance apart is less than the diameter of the berry." This, of course, would apply alike to any kind of stock—grain or particles of grain. When the stream of material going on the roll is so thick that one particle is driven into another, rather than touched by the roll, or when one side of a grain or granule is touched by the roll and the other side squeezed into a mass of similar material, the result cannot but be unsatisfactory. It makes a soft, spongy, pulpy mass. The different particles are mashed together rather than ground in such a way as to separate the various particles one from another. Where feed is heavy, as described above, so heavy that there are certain particles which cannot be touched by the rolls, and where the attempt is made to reduce this material, the result cannot be called grinding or granulation, but rather mashing; or it might be spoken of as compression, and the pulverizing of the material would be merely incidental. There would be required an agitator, detacher, disintegrator, or other mixing machinery, to make it effective as a pulverizer. Such a reduction, followed by such means to effect a result, divests the rolls of all their purifying effects. The material might about as well be ground on a sharp millstone to begin with.

Rolls are not intended solely for reduction machines, but they are used for their purifying effect as well, and when one takes the product of a roll reduction and runs it through some kind of an agitator, he divests this kind of a reduction of all its purifying and separating qualities, and degrades the whole combination to the level of a pulverizing machine.

There can be no exact rule for the proper feed or capacity for roller machinery, but one may suggest an ideal principle which, though it may be unattainable in actual practice, makes a mark for which to reach. If one were to say that the proper feed of a pair of rolls should be such that each granule of material will be touched alike on each side by each of the rolls, he would cover this ideal principle. It would imply a feed

of the thickness of the various single particles of the material to be fed, and not of any two of them. In exact and absolute practice this is an impossibility, but it is a good principle, and we can get as close to it as possible and thus be just that much nearer right than otherwise.

If one were to sit down and make a formula or rule for the amount of stock to go on a roll, he could go at it in about this way: To commence with the wheat and take a 100-barrel mill as an example. Assuming that this was a winter wheat mill, and took four bushels and thirty pounds of wheat to make a barrel of flour, this would make 450 bushels of wheat ground in twenty-four hours, or eighteen and three-fourths bushels per hour. A 100-barrel mill generally has an 18-inch roll to begin with, and eighteen and three-fourths bushels per hour would be the feed of such a mill. If this three-fourths were not in the way, it would be easy to say that a bushel per hour per inch of grinding surface would be the proper feed for the first break. Therefore, in a mill which has four pairs of 9x18 rolls, there would be a feed of 384 barrels in twenty-four hours.

To go farther with the breaks with the same purpose in view, it would be seen that the same amount of grinding surface was usually used for the second break as the first, and consequently the same grinding surface would be suggested for this reduction. Working with this in mind, we go on in the same way, to the third and fourth reductions. The third reduction should have one-third more grinding capacity than the first, which would give it twenty-four inches. The fourth should have two-thirds more than the first, which would be thirty inches grinding surface. In considering the fifth and sixth reductions it is easy to call to mind the fact that in many instances the same amount of grinding surface as on the first is more commonly used within the range of experience than any other. But in the minority instances where more is used, the result of the grinding is better, and this result indicates that the fifth and sixth reductions should have the same amount of grinding capacity as the fourth. This would yield such material as would give it place with the highest grades of reduction stock. It is usually run there in any event, though not always deservingly so. Thirty inches of grinding surface for the sixth reduction advances that product beyond what it would be were there less, and at the same time it cleans the bran and leaves it broad. Where the grinding capacity is ample on the fifth and sixth reductions, the miller can go closer than where the feed is

heavier, and without making soft middlings or red flour in the case of the fifth break, or heavy, fine bran in the case of the sixth.

Pursuing the same line of thought with the smooth rolls, in a 100-barrel mill, the following result would be found: The sizing of the middlings would require the same amount of reduction surface as the first wheat reduction. The reduction of the first middlings would require two-thirds more, or thirty inches grinding surface; the second middlings the same as the first reduction of the wheat; the tailings should have 9x18. Next comes the reduction of the dust middlings. This grade of stock is developed in the first break flour and the middlings separations. It will pass through a No. 8 or 9 cloth and over the 12 and 14 flour cloth. The first reduction of this stock would require one pair of 9x18 rolls, as would also the second. Finally, the red-dog reduction would require the same amount of grinding surface as the first reduction, and in addition a pair of millstones.

We started out with a mill which would make a hundred barrels of flour in twenty-four hours. If a miller could make more money by making 125 barrels, it is not to be supposed that he would deny himself that privilege for the sake of maintaining some one's theory or principles. To recapitulate, on the basis of a 100-barrel mill we have the following:

First reduction	18	inches grinding surface.
Second reduction	18	" " "
Third reduction	24	" " "
Fourth reduction	30	" " "
Fifth reduction	30	" " "
Sixth reduction	30	" " "
Sizing rolls	18	" " "
First middlings rolls	30	" " "
Second middlings rolls	18	" " "
Tailings rolls	12	" " "
First dust middlings rolls	12	" " "
Second dust middlings rolls	12	" " "
Red-dog rolls	18	" " "

CHAPTER XXI.

BOLTING—THE RELATION OF THE REDUCTIONS TO THE SEPARATIONS—THE RELATION OF THE CENTRIFUGAL REEL TO THE BOLTING SYSTEM—THE ACTION OF THE VARIOUS KINDS OF STOCK IN REELS—THE SPEED OF REELS.

At the present time the relation between reduction and separation is closer, and there is less possibility of considering the two subjects separately, than ever before. To speak broadly, the process of milling is a process of purification and separation. Everything tends toward such separation; it is the ultimate aim. Reduction machinery in itself is separating machinery; that is, looking at the subject from a single point of view it so appears. It shows that reduction is a detail of the separating scheme. Reduction machinery makes a separation, but not a division. After a reduction there is a conglomerate of pure stock and impurities, but there has been a separation; the impurities are liberated. There is no positive contact, one with the other, as far as the efficiency of that reduction goes, because it is only a reduction in so far as it liberates impurities. Where that work is not done it simply calls for another reduction.

The positive separation of one grade of stock from another—flour from middlings, or impurities from either—can go no farther than did the reduction machinery immediately previous to its bolting or purification. Therefore if the positive separations are incomplete it is because the separation by reduction machinery was incomplete. It is because of the impurities being improperly or incompletely liberated. Because of the intimate relation which the reduction, bolting and purification methods have one with the other, there is no way of considering them apart. Any change in one of these methods necessitates a change in the other, unless this change is made to bring about a more complete harmony between them.

The more perfect milling operations become, the more intimate is this relation. There was a time in the history of milling when reduction meant little more than pulverizing, and later it was reduction with

incidental separating qualities. At that time the different processes were not so closely allied.

However close the relation of the reduction machinery to separations, the distinction as to the terms reduction and separation must always be maintained in order to give clearness in discussing the general subject. Smooth rolls have been spoken of as purifying machinery, yet it would be confusing to speak of them as purifiers, however much they might aid in that operation.

In speaking of smooth rolls as purifiers, it recalls the fact that the whole system of milling is a system of purification. Purification and separation are practically the same thing. There is no such thing as absolutely pure middlings, and the word is used in a licensed sense which is somewhat different from its real meaning. We try to purify low grade flour on the reels and by the reduction machinery, but we do not do it. But as far as that goes, we do not absolutely purify middlings. The difference is one of degree and not of fact; altogether milling is a process of purification. Rolls, reels and purifiers are each, in the strict sense, purifiers and separators. All that this means is that there is a very intimate relation between the various processes of milling, or rather between various details of a milling process. It may not be so with all alike, but in the minds of many the range of difference between the grinding floor and the separations above, is much greater than facts bear out. A reduction machine is a good one in so far as it reduces the stock and liberates the impurities at the same time.

Most of the communications written by millers have more to say about millstones and rolls than any other subject. Since the introduction of purifiers there has been as much improvement in the bolting as in any other of the milling methods. There has been as great an advancement in the bolting separations as in the reductions or the purifications as ordinarily considered.

It is a popular thing to say that the introduction of the centrifugal reel marks the only radical improvement in bolting methods. The writer cannot see it in this way. To look at the bolting system as it was, say ten years ago, or even six, and know what it is now, it must be apparent to any one that bolting methods have gone through radical changes, and that these changes have contributed as largely to the general result as have the reduction or purification methods. Aside from

the introduction of the centrifugal reels there have been no radical changes in bolting machinery. But this lack of mechanical change does not disturb the fact that with the same machinery and the same machine methods, but with different arrangements and more liberal ideas as to what was wanted, results as entirely different have been reached as could have been looked for by the use of distinct mechanical devices. As nearly perfect work is now done on reels as was originally done by the purifiers. The ideas and wants of the miller, as represented by his bolting arrangements, are entirely different from what they were a few years ago, and as the results are as much better as the methods are different, this part of the mill cannot be said to be behind any other in the march of advancement. If one is still inclined to believe that the bolting methods have not improved to the extent that is here claimed for them, let him consider what his mill would be with the old system of bolting; or, to express it better, if limited by the old ideas and accepted ends of bolting. The change in the system of bolting has certainly been as great as in the system of reduction, and there have been very great improvements in these separations since the successful introduction of gradual reduction machinery. The idea of gradual reduction represents a much earlier period than the date of its successful introduction. It was the purification and bolting knowledge of recent years which made the introduction of the gradual reduction system a possibility. The benefits of the improved reduction methods can never be realized unless the improved separating facilities are at hand. No reduction system, however perfect, can atone for the deficiencies in the bolting methods. On the other hand, a good bolting system will take he work of ordinarily poor reductions and get fairly good results. The ntroduction of the centrifugal reel is merely an addition to bolting machinery. It does not imply a change of system. It means the same thing to bolting machinery that any addition to roller machinery would mean as applied to reductions. The application of the centrifugal reel does not signify revolution in bolting.

The original purpose in bolting operations was to separate the coarse from the fine material, and, to put it broadly, that is about all there is to it. But there are many arrangements which have made the details of such an operation various and complicated. In earlier years about all that was required of bolting apparatus was to make the separations

of flour, middlings, shorts and bran, and this was quite frequently done on one reel. There still remains a large number of mills which are equally as simple. It is no uncommon thing to see a mill with two reels, where the bran runs through them both, tailing off at the last, with the middlings as an intermediate product. This middlings separation is made by putting a piece of coarse cloth on the tail of the last reel. The difference between such methods and those more largely in use is fully as great as the improvement in the machinery of other parts of the mill.

The writer has taken occasion to notice the movement of the material in the reels, from the side and by taking off the tailboards at the ends of the reels. There is quite a difference in the movements of various stocks in the reels running at the same speed and of the same diameter, but containing material of different qualities. Take Fig. 1 as an example. This reel is supposed to be bolting break stock. Most of the material will fall between the rib *A* and the shaft *B*, a part of it falling on the shaft, but most of it sliding off in the direction of *A*. This stock, it will be understood, is heavy and coarse. Referring to Fig. 2, which is bolting reduced stock, which originally passed through a No. 6 cloth, most of the material will fall on the side of the shaft between *B* and *C*, probably more than one-half of it. The direction of the revolution of the reel in both instances is from left to right. It will be seen that the quality of the material with reference to its being coarse or soft has a good deal to do with its movements.

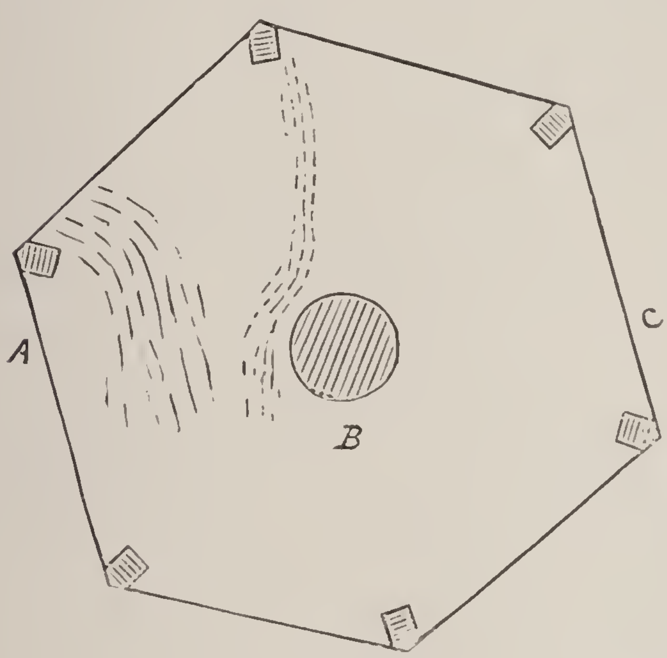


Fig. 1.

The specific gravity of the material in a reel influences the quality of a separation; the heavier particles will go to the bottom next to the cloth and the lighter particles are inclined to float on the top. It can not be said that the movement of stock in a reel is inclined to favor such a condition of things to the same extent as with a sieve, but it is not possible to consider a movement which causes a constant rising and falling of material such as is usually contained in a reel where the

heavier will not go to the bottom, and the lighter to the top, in a degree more or less positive, according to the disturbances in the reel.

Referring again to the cuts, it occurs to the writer that the reel handling stocks represented by Fig. 2 is running too fast to make the best separation. Another thing which has been noticed in the movement of the stock is that there is a larger proportion which falls over the shaft —that is, to the right of *C*, at the head of the reel—than at the tail. There are two reasons for this. In the first place, the stock is softer at the head than at the tail, and for that reason does not discharge from the ribs so readily. In the second place, the load is heavier. Better separations could be made when the reel did not run fast enough to throw the stuff over the shaft, or, rather, ran slow enough to keep it inside the shaft, or between *A* and *B*, as shown in Fig. 1. In this case there would be less disturbances, less mixing of the stock, and a better preservation of the natural condition of things according to its weight; that is, the lighter or fibrous material would tend to the top or away from the cloth, and the heavier to the bottom or next to it, and this makes a separation in a common reel more in accordance with the desired principles of the centrifugal. One might say that when the stock is thrown over the shaft by the rapid movement of the reel that the fall would be greater, and consequently there would be a better opportunity for a more decided separation according to its weight. The writer is inclined to believe that the severity of such an action, and the general disturbed condition of things in the reel brought about by this rapid movement, would more than counterbalance any benefits which it might be hoped to realize.

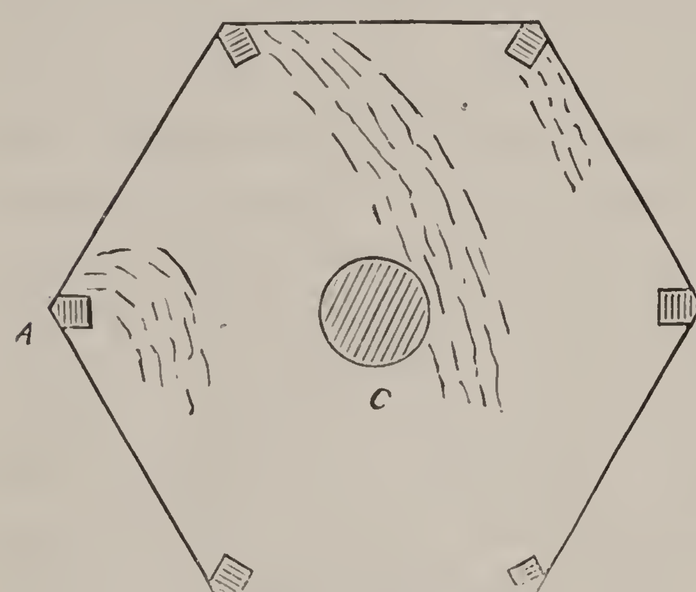


Fig. 2.

Another thing which these observations prove is that what might be proper speed for a reel in one instance or with one grade of stock, would be an improper one in another and with another grade of stock. Thirty revolutions per minute is not too fast for the stock in Fig. 1, but it evidently is too fast for the reel as represented by Fig. 2. On the other hand, it is hardly to be supposed that the proper speed for the

latter would be too slow for the former. All that this statement amounts to is to show that if a miller desires to reduce the speed of his reels, he need not go to the trouble or expense of changing them all, as he cannot hope to realize benefits in every instance. The common speed of reels, which is thirty-two revolutions per minute, is too fast for the best results on soft stock. When other more important things have been corrected, it will pay to look into this matter.

CHAPTER XXII.

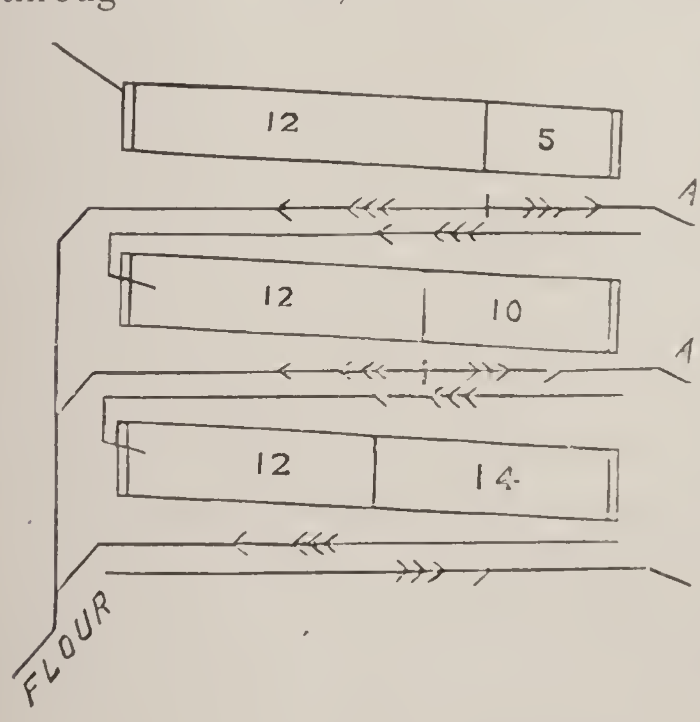
THE NUMBERS OF CLOTH—THE RELATION OF CLOTH NUMBERS TO THE SIZE AND FEELING OF THE FLOUR—THE USE OF TAIL SCALPING CLOTHS—THE PREPARATION OF STOCK FOR BOLTING—THE REDUCTION OF THE PROPORTION OF SHARP MATERIAL A DESIRABLE FEATURE.

It is not long since that millers were asking one another what numbers of cloth they were bolting this, that, or another grade of stock on. These questions were approached delicately and cautiously; they were often intended to be shrewd. These questions were evaded; answered in indirect ways. This same thing prevails to some extent at the present time. The cloth numbers are no longer trade secrets, and for two reasons. In the first place, more is known about them; that is, the knowledge is more generally diffused among millers; and, in the second place—a more forceful reason—the matter of difference between the clothing of reels is not as serious or important in effect, when the difference is at all reasonable, as some of our secretive neighbors would have us believe. Of course it is important to have these things right; but supposing that two millers are bolting certain grades of stock on a No. 12 cloth, and say that these grades are uniform in each mill as regards their purity, it does not follow that the flour will be uniform in quality, either in color or granulation. Because flour is bolted on a No. 12 cloth it does not indicate that all flour will be uniform, even though the stock out of which it is made—the stock as it goes into the reel—is uniformly pure. The granulation and the purity of flour are as much dependent upon the arrangement of cloths and reels, the disposition of the various stocks, as it is upon the numbers of the cloths used, within any reasonable bounds. Because in two different mills there are the same flour numbers working on the same flour stock, it cannot signify that the products will be uniform.

Clothing a reel with a No. 10 cloth does not insure that that reel will produce sharp flour. On the other hand, clothing a reel with a No. 14 cloth does not insure that that reel will produce clean or soft flour. Or, to go a little farther, either one of these reels may produce either sharp

or soft flour. The uniformity of the product of a reel is more often than otherwise dependent upon the uniform proportion of soft and sharp material going into the reel. If there is a larger proportion of sharp material, the flour will be larger grained and not so clear or clean as when that proportion is smaller. To illustrate this point is called to mind a method commonly in use under the buhr system. We will suppose the middlings were dusted over a No. 12 cloth. Now, these dustings were ordinarily flat, miserable looking and miserable feeling stock. On soft winter wheat they had a feathery texture and appearance. Take these same dustings which had gone through a No. 12 cloth, and put them in a separate reel clothed with a No. 12 cloth—the same number through which they had originally passed—and the product of flour will be nice and bright. This shows in an extreme degree the benefits to be realized by reducing the proportion of sharp material. Whereas, the No. 12 cloth, with the middlings in the stock, gave a product which was unsatisfactory, when these middlings were removed, the product of the same number was white, clear flour. This means that the proportion of sharp material in that reel was reduced on the stock made softer, and therefore the product improved.

The cut illustrates this same thing, carried out in another way. It will be supposed that the stock going into reel is a floury one, and at the same time contains middlings as coarse as those which will pass through an o cloth, and from that on down in fineness to flour. But the larger proportion of it is flour stock. Let it be supposed, for example, that these reels are bolting the flour and middlings of the grades mentioned from the four middle breaks. It will be noticed that each reel is clothed with a No. 12 cloth at the head and that there are scalpers at the tails of the two first reels. Now, as mentioned before, the stock going into the first reel contains middlings as coarse as will pass



through an o cloth, and from that on down finer, but with a good proportion of flour. For the latter reason the flour from a certain part of

the first reel will be all right and satisfactory. But as the proportion of sharp material increases, because of the flour being taken out on the first 12 cloth, it becomes necessary to reduce this proportion of soft stock, which is done by placing the No. 5 at the tail. Perhaps it would be better if there were more of this latter cloth. The tail of the No. 5 would go to the grader or purifiers, together with that proportion of the product of the No. 5 next to the tail which was sufficiently free from flour. Now, by removing these middlings which will pass over the 5, or that portion which is taken off which goes through the 5, the proportion of sharp stock is reduced, and is again soft enough to be bolted on a 12. The same operation is gone through again; flour is taken through this 12 cloth on the second reel, and the proportion of middlings is again on the increase, and it is necessary to take off more middlings so as to make the stock soft enough to be floured on the next reel. This is done by putting the 10 cloth on the tail of the second reel. The middlings which pass through the 5 pass over the 10, and the desired object of reducing the proportion of soft stock is accomplished; that is, we have the cut-off from the 12 and the product of the 10 to go to the third reel, which is soft enough to bolt clean on the 12 cloth of the third reel.

This will work out in actual practice. It is only necessary to keep down the proportion of sharp material in order to make clean flour through a 12 cloth, or at least as clean as it would be from such stock on a finer cloth were the conditions less favorable. Say that the 12 cloth of the second reel did not bolt the flour as clean or as white as desired, that would indicate that there was too much sharp material coming through the 5 cloth, which might be sent off with the tail, which could be done by closing the slides under the tail conveyor. With a light load on the reel this would work out in the same way in the relations of the second to the third reel.

The experience of millers who have tried these arrangements will justify the correctness of the principle, and great benefits can be realized in mills where this principle is not in use.

The above gives prominence to the expression 12 cloth, but this number is used merely as an illustration.

CHAPTER XXIII.

ARRANGEMENT OF BOLTING DEVICES—THE PROPER CONDITION OF STOCK TO BOLT PROPERLY—THE SCALPING OF MIDDLINGS BEFORE SEPARATING FLOUR—PROPER AND IMPROPER METHODS COMPARED—THE VALUE OF PROPER SCALPING ARRANGEMENTS.

In the last chapter something was said about the relation which the proportion of sharp material in a reel bore to the product of that reel, and an illustration was used to show the effect of decreasing the amount of sharp material in the reel at the same time that the flour was taken out. This was done by placing scalping cloths at the tail of each reel which gradually increased in fineness, counting from the first reel downward. Thus the stock became finer as it passed from reel to reel. There are other means of accomplishing this result, which will be mentioned in the course of this chapter.

The whole object of this is to keep the material going into the various reels in a condition so that it will contain the proper proportion of soft material to bolt clean, and at the same time a sufficient amount of sharp material to give the reel its required capacity. One great point with the centrifugal reel is that it will bolt softer stock than a common reel. It will re-bolt flour which would paste a common reel so that little or nothing would come through.

This principle of keeping the stock as soft as possible to bolt is one in which the writer has great confidence. By such an arrangement it is possible to keep thoroughly dusted stocks going on the rolls or purifiers, which facilitates the work of feeding and purification, and gives the rolls and purifiers less to do and a better chance to do their work, and to do it well; therefore a less number of reductions of the middlings and other stocks is necessary in order to finish. It is quite often the case that floury material is run on the rolls to be reduced, when such a reduction is not necessary. By merely removing some middlings or sharp material, which there is in this stock, it can be bolted and will produce white, clean flour. Then by taking the middlings which are separated from this stock, they can be reduced and thus accomplish in a direct

and simple way, and at a single reduction, what it would have taken many to accomplish were the floury stock and other material run to the rolls together.

Calling to mind other methods of the application of this principle, stock from the sizing rolls will be taken. One way of arranging and clothing for such separation is here shown.

Here the stock from the rolls is going on a No. 12 cloth and before any of the middlings are taken out, flour is taken from the stock. What goes through the cloth goes into the next reel, which, to compensate for the probable result with a coarser cloth, is clothed with a No. 14, for the flour portion, and No. 7 through which to take the fine middlings for the middlings bin. The stock which goes over the No. 7 ordinarily goes to a purifier. The details of such an arrangement, though not uncommon, are altogether objectionable. It is suggested that the arrangement shown in Fig. 2 be substituted.

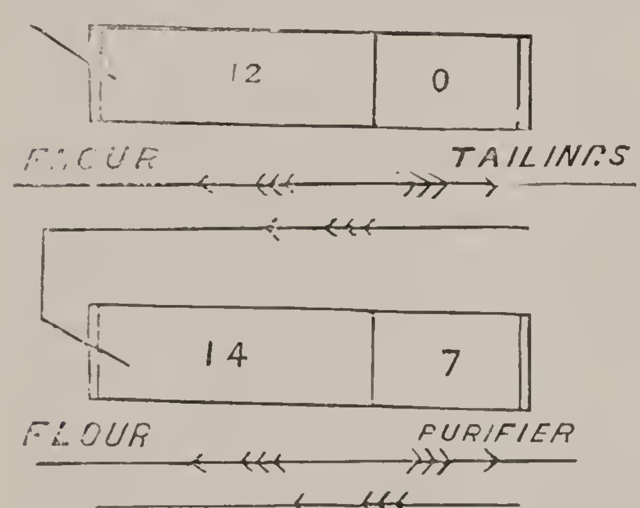


Fig. 1.

Here the product of the sizing rolls goes on a No. 7 cloth first, where the flour and fine middlings are taken out. Then the material goes through the 0, is in a dusted condition, and can go directly to the purifiers. The stock which goes through the No. 7 is soft enough to bolt clean and bright through the No. 12 cloth on the next reel. The tail of this reel is No. 6, which will carry over some stock that originally went on the No. 7. This is on account of its being softer in this reel—that is, containing a smaller proportion of sharp material—than on the reel above where it went through the No. 7 cloth, and had the coarse middlings to make it bolt freely.

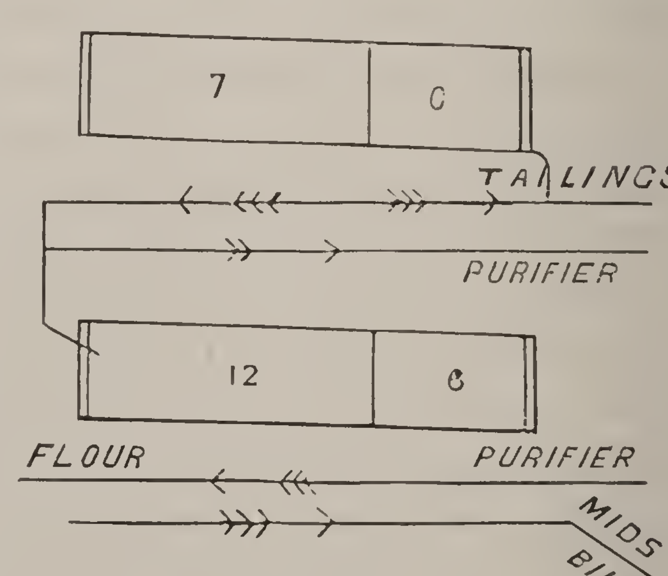


Fig. 2.

The product of the 6 cloth will be much cleaner and brighter than that of the 7 on the tail of the reel in the other instance, because it

does not have the heavy, coarse middlings out of which the flour has been taken, and which will wear off or beat their impurities through the cloth. It is very clear that this arrangement shows benefit to the flour, as well as the middlings. In the first place, the middlings are dusted over a No. 7 cloth, which takes out all the flour and fine middlings; and secondly, the flour and middlings in the second reel are benefited by not being associated with the heavy and sharp stock above.

It is not long since the arrangement (or its equivalent) shown in Fig. 3, was used in separating the middlings and flour of the four middle breaks.

Such an arrangement has the same objections as the one shown in Fig. 1 in the handling of sizing stock. In the diagram here given there is flour, together with all grades of middlings as coarse as 000, going into the first reel, and flour is taken off on the first one through a No. 11 cloth. It might be a 12 or 13, and the evil of such an arrangement would be as great. In any event, coarse middlings go off over a 2 cloth, and

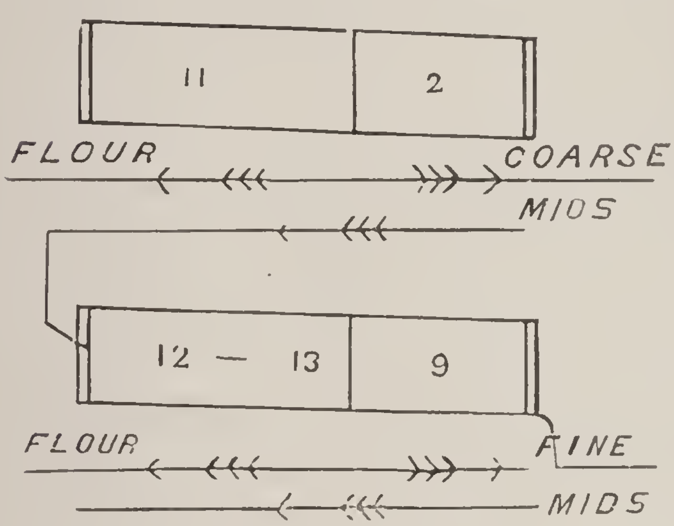


Fig. 3.

the product of this cloth, together with the No. 11, would go into the bottom reel, and it would still be too sharp to bolt clean on the numbers given, unless a larger portion of the product of the No. 11 went into this reel, in which event the stock would be too soft to dust the middlings which passed over the 9 cloth. Thus it will be seen that in one instance the flour will be sure to contain more impurities than it would under more favorable circumstances, and in the other the stock would be too soft to dust the middlings over the No. 9 cloth. This illustration is given because it is one which is known to have been used in a number of instances, with the result described.

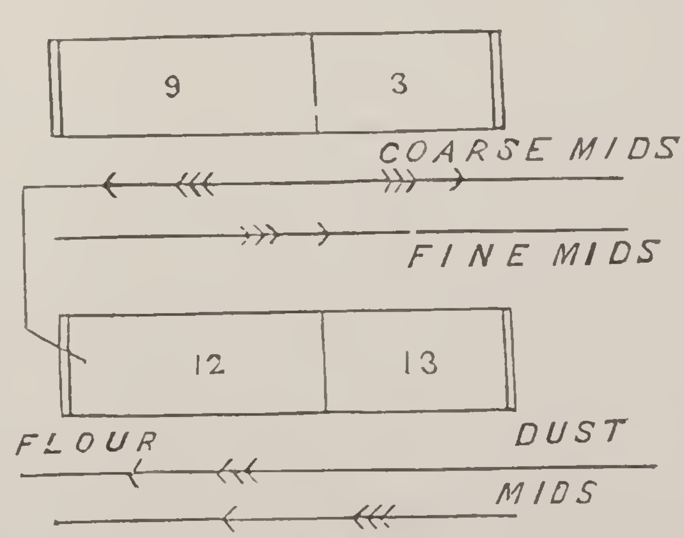


Fig. 4.

Having had experience with the arrangement illustrated in Fig. 3, the one given in Fig. 4 is what suggested itself as a remedy.

Here the middlings are scalped and graded first and the flour taken out afterward. The flour and dust middlings are taken out through No. 9 cloth and the coarse and fine middlings graded over a No. 3, or any other desirable number. This brings the stock going into the second reel soft enough to bolt clean and still sharp enough to bolt freely, it having originally passed through a No. 9 cloth. This arrangement not only brings this stock soft enough to bolt clean, but is also sharp enough in the first reel, having all the large middlings with it, to thoroughly dust all grades of middlings over a No. 9 cloth, and before it gets to the grading number. This is quite desirable and saves a dusting reel, which would be necessary on soft wheat according to the first arrangement. It takes advantage of the large middlings to aid in dusting, and at the same time gives the stock to the second reel soft enough to bolt clean.

The clothing of the upper reel is a good deal a matter of judgment. In a low grinding buhr mill a No. 9 cloth would be too fine, or, in fact, in any mill where the grinding is done on buhrs. These illustrations show the principle and details of arrangements to reduce the proportion of sharp stock before taking off flour, and attempt to show the benefits to be derived therefrom.

CHAPTER XXIV.

THE MEANS OF MILLING PROGRESS—THE EFFORT TO BE CLOSE AND SECRET—A LARGE NUMBER OF FIRST-CLASS MILLS DESIRABLE—THE EFFECT OF AN INTERCHANGE OF IDEAS—THE EXPERIENCE WHICH DEVELOPS INVENTIVE MILLERS—ORGANIZATION IN MILLING MATTERS—THE LACK OF UNANIMITY IN MILLING OPERATIONS—REDUCTION BY CORRUGATED ROLLS BETTER UNDERSTOOD THAN SEPARATIONS—THE SAME NAMES DO NOT ALWAYS INDICATE THE SAME STOCK—THE DEVELOPMENT AMONG MILLERS.

What advancement there has been in milling, and whatever advancement there is to be, has and will come from a united experience and an interchange of ideas. The mill that has come the nearest running with closed doors is not the one which has done the best work, made the most money, or contained the best help. One man, or a dozen, will not, cannot work out the milling problems of the future any more than did the same number in the past. In the winter wheat region, where there is the poorest work done, there is the greatest show of closeness, as to the equipment of the mill and those engaged in running it. In the best mills of the Northwest there is more freedom, less show of secrecy than in the little mills. If in Minneapolis there had been, during the past milling years of that city, only one or two first-class mills, it cannot be said that even this number would have enjoyed the prosperity which they have enjoyed in the company of a large number of equally well-equipped, ambitious and successful neighbors. It is the aggregate of the mills, as well as their splendid work, which has helped to make the money for the individuals. It has given Minneapolis a reputation which has attracted buyers from all accessible markets. This is because of its reputation for making a large amount of first-class flour, which reputation it would not have enjoyed to its present and past extent, with a small number of mills. A colony of well-equipped mills, in a town of Indiana or Illinois, would benefit the individuals of that colony in the same way. A State which has only a small number of mills is not the best State in which to build a new one; but rather a

region which has a large number of first-class mills and, consequently, one which has the reputation of furnishing good flour. There is at least one city in the winter wheat region which was formerly a large milling center, and was so prominently known as a point where good milling was done, that nearly all the mills of the neighboring States regarded it as being to their advantage to brand their flour as being made in that city. It is to the advantage of good millers to have other good millers around them, in that it enhances the reputation of the flour product of that locality. Furthermore, such a course attaches additional value to the price of every piece of productive land in that locality, and, in that way, adds to the wealth of the whole community—which means each individual in it. One can best have wealth where there is wealth to draw from. Thus it will be seen that to be isolated in the possession of milling knowledge is not a desirable state of affairs, where one wishes to meet the markets of the world.

The effort to be close and secret with milling information is the spirit which, in its completeness, would keep all in one low condition. It is the spirit which would have made all invention impossible. If it were possible for men to refrain from uniting their ideas, from talking about their work, such a thing as human progress would not be known. The united ideas of many men made the steam engine. Watt did this work for those who went before him. He put their ideas in tangible shape, and those who followed him have been adding a little all the time until we have the better machine of to-day, which no man can call his own. There never was, and never can be, a man who can break short off from the train of thought of other men and do something, invent something which is distinct and apart from the ideas of his friends and ancestors. He who has the credit of being a great inventor is simply a great accumulator—one who has that quality of mind which takes up what others have been thinking of in a way more or less misty, and brings all to a climax in a useful machine, or other combination of thought. He is a climax; the others preparatory. This shows what progress means, and how it is brought about in milling as well as in anything else.

The most successful millers are not those whom the world would call original or inventive men. They are quiet, level-headed, inquisitive people, who know a good thing when they see it, and whose only idea of success is in the ultimate result. They don't care whether an idea is their own or that of somebody else, so that it does the work. They

know how to profit by their own mistakes and other peoples' successes. They are organizers and systematizers of what they believe to be right in milling. Narrow personal vanity does not embarrass their movements. It is true that the experiments and changes, which have been necessary during times past, have caused a great many millers to be restive and inclined to tinker with and alter what might be profitably let alone.

There is no unanimity of ideas as to what are the true principles connected with gradual reduction milling. All seem to be united in regard to the reductions themselves. All seem to believe in the utility of gradual reduction by rolls. Millers are unanimously of the opinion that they ought not to have less than six reductions, if they have the money to pay for them, and again they seem to approximately agree as to the corrugations which shall be used on each break. Of course there is the occasional crank who indulges in wide departures from accepted methods for departure's sake. There are those who desire to be unusual, who get a lame sort of satisfaction by standing alone even though there be no rhyme or reason in their departure. A man who uses twenty corrugations on the first break cannot do that thing rationally. Reason would lead him to see that the fine corrugations are calculated to cut the bran, as it is on the original wheat berry, into small pieces. If reason does not show this thing, the results certainly do. With fine corrugations on the first break, the third and fourth breaks would show a fine, stringy mass, being distinguishable from the stock usually going to such reductions by every evil and deranging quality which can be imagined at this stage of the process. The writer asked a man who was doing just this thing why he did it, and he answered, "because he thought it did better work." He was asked if he were sure of it, and he said he was. He voluntarily went on to say that he had never heard of such an arrangement before, and that it was an original idea with him. He had another original idea, as he claimed, which was to pass all his middlings through smooth rolls immediately after passing them over a middlings scalper, after which he scalped or dusted them again before purifying them. The point which he saw here was, as he explained it, that he did not have to take care of so many large middlings; that they were more uniform in size. While it is desirable, but not possible, to have middlings of an approximately uniform size before purification, the evils attending the

means of reaching such an end are so monstrous as to render such an idea entirely unworthy and unreasonable.

It has been said that there was a certain amount of unanimity as to the reductions, and an illustration of a very startling exception was given. The original statement is qualified by including particularly the use of corrugated rolls, there being more harmony as to how to use these rolls in the reduction of wheat than in the use of any other machines. When it comes to separations, there are apparently as many different ideas as there are mills. Every miller has his own peculiar ideas as to separations, and exhibits as well what might be called a certain amount of individuality in the use of smooth rolls and in the classification of stock which goes thereto. One reason why there is this great diversity of methods and so-called systems, is because it so often happens that the miller knows only his own way, and as no two men are alike in their way, when there is no concert of action, the general methods must be widely different. As we become more and better acquainted with one another's ways we will more nearly approach a common system, and at the same time that we do this, we will do better work. The way in which the change in our milling system has been worked out has been very wasteful, both as to energy and money. There have been too many single-handed struggles. Millers working next door to one another have been alone in their work. Where one man tries to do all himself, and by and for himself, he is taking a larger contract than was ever accomplished by one man. In the end he must accomplish his work by help from others. The best milling system which we are to have will be that which is made up of a united experience. It will be the system in use in nearly all the mills in the country. There will be few variations as to details. When this time comes we will speak of a milling system with a common understanding as to what is meant. Our discussions will be on very narrow points, something like those indulged in by the employes of cotton and woolen mills. These bring harmony as to all the general principles—only the fine or small points being left for general discussion.

It is hardly necessary to illustrate what is meant by the great difference in the management of mills, in the classification of material and in the use of rolls, reels and purifiers. We have only to glance around us, or maybe to look at the history of our own performances. We may

take the tailings of one mill and compare them with the same stock in name in another and find the appearance entirely dissimilar, so much so as to indicate that all previous separations must have been different. We find the flour from the tailings in one mill white and bright looking. We find the tail from the tailings reel white and flaky and going anywhere that will give it a good shaking up and keep it from passing into the feed. In the other mill we find the tailings flour dingy and the tail of the reel poor and thin and spouted directly to the bran duster. We find these same differences all through the mill. We find them in the cleaned wheat, in the break flour, in the middlings, in the patent flour, and in the low grade flour and feed; and we find the same difference in the prices received for these products. There are no products in flour mills which will compare in uniformity with the standard sheeting of cotton mills which is made in the same way and at the same cost by nearly every cotton mill in New England. As the mechanical system approaches uniformity the system of handling or managing will, in that same degree, become more exact and uniform.

There is a system in the operation of cotton mills which, with modification, can be applied to the operation of flour mills, and which, in its completeness and efficiency, is far ahead of anything of which most of us have knowledge. In speaking of system in this sense, it is to separate distinctly and clearly the thought as to process and system in a mechanical sense. Particularly is meant the business system and the organization of the help, in the operation of the machinery. It is safe to say that the entire profits of cotton milling, in years past, have been derived from the little things which are totally neglected in nine-tenths of all the flour mills. In the cotton mills they figure and calculate to a nicety and exactness which would be astonishing to those not familiar with their methods. The most wonderful thing in these calculations, which trust to such narrow and almost imperceptible points for margins, is that they are realized.

The longer people think, talk and argue about a given subject, the less there is to talk about. All arrive virtually at the same conclusion. All difference of opinion is settled by reason and experience. Facts eventually override all prejudice. There may be three classes of opinions as to matters pertaining to our daily living. There are the opinions born in us—opinions for which we will fight. Then there are those we have fallen into accidentally, hardly knowing how, which we hold to less

tenaciously than the former; and, finally, there are the opinions at which we arrive through a process of reasoning, which latter class we can talk and argue about without getting disturbed or excited. These are opinions which are readily changed in the same way in which they originated.

The older processes of milling were not calculated of themselves to make thinkers of the men who ran the mills. The disposition was to do as had been done before and without other basis for so doing. There is nothing in the present processes which has not been developed by thought and reason. The millers who operate the mills of the present time are generally thinkers, because the results in such mills have been developed by the thoughtfulness of the people of the present times. The millers of this time and generation are less mechanical in their nature or disposition than will be the millers of the next decade, providing no serious changes be made in the processes of the present time. It is, and has been, the work of the millers of this generation to revolutionize the processes of milling. It will be the work of the next generation to run these mills, and in time they will develop into the same machine condition as the millers of the earlier times of which we speak. It will not be a question of processes or methods, but simply the doing with machines that which is set before them to do. There will be none of the inventive or logical qualities required of the operative miller.

The same experience which has developed the inventive and logical qualities in millers, such qualities being necessary to work out the details of gradual reduction milling, will make it difficult for them to settle down to the mere running and operating of the mills. It is the same inventive spirit which has been so brought about and developed which is liable to overreach itself. For this reason we will continue to have trials and experiments in particular details of milling when trials and experiments are no longer necessary. There will be, as there already have been, machines put on the market for which there is no particular use. This is justified to a certain extent by the millers expecting and demanding something new. This develops a disposition to hunt something for a machine to do rather than to seek for something which will do a certain thing. But all this is preparatory to the formulation of milling ideas and their eventual incorporation into a complete milling system—a system which is the result of the reasonings and experiences of times past. At that time there will be no great difference as to the methods pursued in the different mills. The milling results will be due more

largely to the operation of the mills, as to their difference from other mills, than to differences of system. Take the present time, for instance; there are many mills which are doing superior work because of superior methods of reduction and separation, but the difference is not nearly so great as it once was. The margin as to the quality of the goods between different mills is gradually narrowing. It will become closer and closer until the margin is less marked and the only difference to be distinguished is owing to the lack of fulfillment of the milling idea as understood, or, perhaps, the quality of skill and ability displayed in the operation of the mill.

A JOURNEY THROUGH THE MILL.

CHAPTER XXV.

THE CLEANING OF WHEAT—PURPOSE OF WHEAT PURIFICATION PREVIOUS TO REDUCTION—RELATIVE IMPORTANCE OF WHEAT CLEANING TO VARIOUS GRADES OF FLOUR—DEVELOPMENT OF CARELESS METHODS—OVERWORKED CLEANING MACHINERY—DISPLACEMENT OF CLEANING MACHINERY—GRADUAL CLEANING A PART OF THE GENERAL MILLING PROCESS—REDUCTION OF THE YIELD BY GRADUAL CLEANING—REDUCTION IN THE PERCENTAGE OF LOW GRADE FLOUR BY MORE PERFECT WHEAT CLEANING—AMERICAN AND HUNGARIAN WHEAT CLEANING METHODS COMPARED—GRADES.

With this chapter we begin what may be called a journey through the mill. We will first take up the wheat as it enters the mill, and follow it through the cleaning apparatus and the reduction and separating operations, considering at each stage of the process the milling qualities and peculiarities and method of handling the various machines, and the principles involved in their operation.

The cleaning of wheat and the purification of middlings have in mind the same result. This statement might be turned around and read "the purification of wheat and the cleaning of middlings." Custom and precedent are in favor of the first expression. Milling the wheat, properly speaking, may be said to begin with its reduction, its handling by the cleaning machinery being the preparation for the purification process. And it is clear to see that any impurities taken out previous to reduction, renders the work of the separations infinitely easier than it could possibly be were this process deferred until after the reduction of the wheat. The purification of the wheat after it is reduced cannot but be an incomplete process. Only such particles as are of sufficient size, and detached from the outer coverings of the grain, can be pure or in a condition to be purified. The finer particles, or flour, are more or less intimately mixed with the portions deleterious to its bread making qualities. Therefore, any impurities taken out of the wheat previous to its reduction means more as applied to the final result than can any of the methods of purification which follow. The

taking out of the impurities at the tail end of the mill always had an unnatural look to the writer. It always appeared that there would some time be a method which would not allow the impurities to come out after the better portion had been removed. This would mean a separation of the impurities from the flour, and not the separation of the flour from the impurities. It seems that the wallowing of a lot of material through a reel wherein the impurities were retained until the last is an unnatural process, and one which in time will be supplanted. By such a way—that is, the common way—the purity of the flour is dependent upon the proportional purity of the entire stock or conglomerate as it enters the reel, and not upon the quality of the distinct flour particles. By this is meant that there may be a small proportion of never so high a grade of flour mixed with a larger portion of impurities or inferior flour. The quality of the flour that comes from the reel which bolts this stock is influenced only by the proportion of impurities, and not by the quality of flour stock which may be mixed therewith. The only effect which this high grade stock has, is in reducing the proportion of deleterious material. It is well known that the lower grades of flour contain a proportion of the best stock in the wheat, together with a certain other proportion of the worst and poorest stock. As the quality of flour is rated by its weakest points, the result is apparent. Such a result is brought about by a method of milling which carries by far the largest portion of impurities through the mill, in the meanwhile taking out and grading the desirable portions. On the face of the matter this looks unsatisfactory, and the suggestion would be to remove, in so far as it is possible, the impurities in and of the wheat previous to its milling. But in the light of the present milling information, nothing of that kind is at hand, nor have experience or experiments proved anything worthy in this direction. But it does look unreasonable that we take out the impurities at the tail end of the mill, or during the various detailed processes, and after the flour and middlings have been removed. All this goes to show the importance of wheat cleaning or wheat purification. It shows that the nearer we come to purification in the beginning, the more we can add to the value of a bushel of wheat in milling. It shows, further, that the nearer we can come to purification at the head of the mill, in the same proportion will the value of the products be enhanced. In the present instance this calls our attention directly to wheat cleaning methods.

The cleaning of wheat is more important to the break flour than to the middlings. Imperfect wheat cleaning shows more plainly in the clear flour than in the patent. The flour which is made in the effort to reduce the wheat to middlings is contaminated—is rendered impure in proportion as the wheat is improperly or imperfectly cleaned. The particles of impurities which are of the same size as the flour particles cannot be removed. The scouring of the wheat makes a separation which is prolific in its benefits to the break flour. The natural dust of the wheat must, of necessity, go into this grade of flour if it be not removed by the cleaning machinery. Wheat cleaning is neglected in American mills. Our wheat cleaning machinery is in good condition. We do not lack in its quality, but we do not use enough of it. We rush a lot of wheat through a separator, through a scourer, into a brush machine and then to the break bins. We put it through the motions. It is a habit with us to do this thing, and, in common with many other habits, there is a certain degree of carelessness about it. There is no denying that there is a great deal of carelessness in wheat cleaning. It occurs to me that if the miller were to sit down and think that whatever impurities are left in the wheat will go into his break flour and reduce its value in the market so many cents per barrel, he would reform his ideas, or lack of ideas, in regard to this wheat cleaning matter.

One great reason for the carelessness of wheat cleaning methods lies in the fact that about all there is left of the older methods of milling is that of wheat cleaning. The attention of millers is particularly attracted to new machines and new methods, and in their development it is not to be wondered at that something which was old, something which did not participate in the change, should be regarded with a certain degree of indifference. There are millers to whom this talk does not apply, however.

As to methods of wheat cleaning, the subject is one which can not be treated with any degree of freshness. The method of wheat cleaning—that is, the course of the wheat, the operations to which it is subjected—is better understood than any other of the milling processes. The faults in wheat cleaning are not faults of ignorance; they are more faults of carelessness and thoughtlessness, a course which leads millers to double the capacity of the mill, oftentimes, without making corresponding changes or alterations in their wheat cleaning machinery. One thing which may be done is for the miller to examine his machines, their

numbers, in order to determine their size, and then refer to the catalogue of the maker and see if their capacity is what it should be. This thing often happens: the machine is large enough if run twenty-four hours; if run twelve it is obviously too small. A machine never should run to its maximum capacity. If it could do good work when so operated, it would naturally be supposed that it would do so only under ideal conditions. Competition among the makers of wheat cleaning machinery naturally tends to cause them to exaggerate the capacity of their machines. One which is advertised to handle from forty to sixty-five bushels an hour will naturally do better at forty than on any other feed. The number of the operations should always be considered. If a machine is arranged to take out the heavier and coarser impurities, it is natural to suppose that it will not operate with equal facility and success upon the finer, smaller, lighter and more dangerous impurities. The warehouse separator removes the coarser and larger material, together with the larger volume of dust. There remains other foreign material to be taken out in the course of subsequent operations, and which can best be done by machines which are constructed for the purpose of recognizing finer and more delicate differences, which become necessary in the cleaning of the wheat. It has often been noticed that when a feed on a machine was too heavy—much more than could be handled effectively—the miller would buy another machine of the same size and pass the same stream through it, hoping thus to remedy the evil. But it cannot be done in that way. It is hardly within the range of possibilities to expect any number of overworked machines to accomplish a desired result. Taking the case cited, benefits would be realized only by dividing the stream, sending half of it to one machine and half to another. This same principle applies to the operation of any machine in the mill. For instance, a brush machine may have twice as much to do as it ought to have; that is, a stream twice as large as should naturally and properly be expected, is made to pass through it. And, by the way, this is not an unusual condition of things; and, at the same time, it is not unusual to see two such machines working on the same large volume of stock. There is a brush machine made which absolutely rebels against excessive overwork. It carries over whole wheat into the screenings pile.

A great many wheat cleaning machines are overworked, not because they are too small for the size of the mill, but because they are run at

too heavy a feed at various intervals during the running of the mill. To explain: The miller puts on a heavy feed, runs his cleaning machinery for an hour or so, accumulates a stock of wheat in the hoppers, and then throws out this part of the mill until the supply is nearly exhausted, when the operation is repeated. Instead of putting on a light feed, and one at which the machine would do the best work, and running it a greater number of hours, he hastens the work, through force of habit in some instances, and, the more discreditable motive in others, the desire to have a smaller amount of machinery to watch than the necessities of the case would demand. There is quite as much necessity for wheat cleaning machinery to run all of the time as there is for a millstone or a buhr. If it is desired that it should only run part of the time, its capacity should be estimated accordingly, and it should not be forced to do unnatural and incomplete work. When the wheat is poured on to a separator, say, in a large volume, the suction on the wheat, as it enters the machine, cannot be uniformly distributed throughout the grain, and for that reason cannot take out a uniform quality of light, poor stock. At the same time there will be a certain proportion of the light stock removed, and a certain other proportion of rich stock or whole wheat taken out, while the wheat which is supposed to have been cleaned will contain light impurities which should have been removed. Here the miller finds himself between two fires—rich offal or screenings on the one hand, and poorly cleaned wheat on the other. The rich screenings are brought about in the same way as the other rich offal—by the heaviness of the feed—the screens being overloaded and thus forced to tail over in a wasteful manner. What is said of the action of the suction of the stock as it enters the machine applies in a like manner to its work upon it as it leaves it.

Now, when this stock comes to the smutters or brush machines, the same objections are to be met as to the suction, and as to the quality of the work when acted upon by the brush or beaters. They cannot do their work properly with this overloading. It means broken wheat, which implies a waste and a general abandonment of the idea of scouring and brushing. One often hears it said of various machines that they break the wheat.

It is the writer's experience that any scouring machine which will do its work properly under careful and judicious management, will break the wheat when excessively overworked. By this is meant any machine

which operates with beaters, not brushes; but at the same time it is not believed that there is a machine on the market which will break wheat when worked to its proper capacity.

I do not think that the active working miller is responsible for any of this. It is the result of custom, rather than of studied neglect. It is a course which has had the support of millers for years. I remember to have heard it said many times that the wheat did not have to be cleaned so well under the new process or gradual reduction methods as under the older system of milling, and I think it is true that the introduction of the new systems of milling marked a commencement in the decline in wheat cleaning operations. It is believed, furthermore, that the stringency of the times will correct this evil, as well as many others which have developed during the periods when the business was more prosperous—times when the miller did not have to be so careful in order to make a fair profit on his work. In the present condition of things there is nothing the miller can do which will add more to the value to the bushel of wheat after it is milled than its proper cleaning previous to reduction.

The writer can think of but few mills which would not be materially benefited from a financial standpoint by doubling their wheat cleaning outfit, and while they are increasing this outfit, it is not impertinent to suggest that the attention which is given it should be increased in about the same proportion. The "starting up" of the wheat cleaning machinery is often about all the attention which it receives. The miller will start the machines going, put on feed as long as the separators will stand it, and pile it through the brush machines and thus to the bins. About all the attention that the wheat receives is to see that it makes the rounds, to see that the separator screens do not run over, and that the brush machines do not choke down. The offal from the latter is considered more often in a negative than in a positive way. It is examined to see if it is too rich, not to see whether it is rich enough.

If one will keep his eyes open in looking about the majority of mills, he will find that the wheat cleaning machines are used merely to run the wheat through. It is simply a matter of form. The most attention that is given them is to see that they do not draw out too much by friction. Very little attention is paid to the positive work of the machine. As to whether the grain is scoured properly or not, little care is taken. As said before, it is simply to get the wheat through. It is purely an inci-

dent in the passage of the wheat from the bins to the stock hopper. It is a tradition rather than a careful mechanical operation, and the wheat cleaning machinery is neglected more than any other in the mill. It is the only old process that there is about milling. Everything else has been altered and changed, while about all the change there is in wheat cleaning in a large number of mills has been in the line of retrogression, rather than of progress. Very few of us realize the importance of wheat cleaning. It is an indefinite something which has to be done in the natural course of things. We hear it said that Mr. So-and-So is a good grinder, or that George is a good hand with the purifiers, but do we as often hear it reflected to the credit of these men that they are as good hands with the smutter or the separator? It does not seem to be so worthy an ambition to be regarded as an expert in handling this machinery as it does in the grinding machinery.

The improper cleaning of wheat means that there is more care and attention required in the bolting of the break flour; more waste of such flourr because of the stock which has to be carried over to lower grades and because of its contamination. And then the middlings suffer, and, as these high grades are injured, the depreciatory effect is felt in every subsequent operation in the process of milling. It should be remembered that as we clean the wheat we are helping to purify the break flour, and that, as we make this flour pure, we make the cut-off and tail of the break flour reel cleaner and better, and in this way include the intermediate and lower grades of stock. As we clean wheat we are purifying middlings, and as we increase the purity of the middlings we increase absolutely the purity of the patent flour. Furthermore, the cleaner we get our wheat, the better yield we get, the less flour we get in the feed. This comes about by having, as we said before, cleaner break stock and cleaner middlings. There is a smaller proportion of cut-off from the flour reels and a cleaner quality of stock to go to smooth roll reductions Hence there is less milling to do, less impure stock to be handled by the rolls, more flour to be taken off after each reduction, less flour to be carried from one reel to another, hence less work to be done at the tail end of the mill, less stock out of which to make low grade flour, and less stock to go into the feed pile. We see that after the wheat is cleaned properly, there is less work for every machine in the mill to do than if less care were taken with that process. We can see that it is difficult to begin too early to work for a yield, and

that we can reduce the yield by the proper and more complete cleaning of the wheat, and more effectually than we can by the proper and more efficient cleaning of the bran when the wheat cleaning is neglected.

It is not infrequently that we hear of a cleaning machine being taken out and replaced by one made by B. On the other hand, we hear of B's being taken out and replaced by A's, and so on. It may be said that one of them is wrong. The chances are that both of them are wrong, in that neither should have made the change. After milling machinery has been in use for a year or two throughout the country, and so long as it is a part of a milling system in vogue, there is no reason for regarding the machine as an experiment. No business man is going to make and sell a machine any great length of time, if he knows it will not do good work, and if he does not know it, some one will find it out for him. Therefore, it may be assumed that a miller who will throw out a machine which has passed the experimental stages, and which is a part of a system in general use, is reflecting more to his own discredit in so doing than he is to that of the maker of the machine. One thing which the American miller has not learned thoroughly is to do the best with what he has; not merely to run his mill without care as to its general repair, but to get the very best possible work out of each piece of machinery in the mill, and not to be constantly wishing and scheming for new machinery, changes of system and changes of method. Many indifferent millers have kept good positions for a long time by making constant changes in the mill. This may appear to be a strange thing to say, but it has been done in this way: The miller's plan is to keep something ahead of the proprietor's hopes and anticipations, if this or that thing is only forthcoming. When one thing is supplied another is called for, and the result is a constant series of hopes deferred. The mill runs along, doing ordinary work, and perhaps making a little money, and the deficiencies are supplied by promises as to the future. This statement of a frequent disagreeable state of affairs is justified by common knowledge.

It has been the development of practice that middlings could be made in the largest quantities by a gradual reduction process. It has been further developed that the middlings produced could be best purified by gradual means. Now, as exhibiting the utility of gradual operations in milling methods, we have to notice the results of gradual wheat cleaning operations. During the year 1884 it occurred to a miller that slower

and more gradual methods might profitably and effectively be applied to the cleaning of wheat, which idea he put into practical operation. The result was an improvement in yield, a reduction in the percentage of low grade flour, and an advancement in the quality of the higher grade products. Instead of passing the wheat over the separators once, he passed them over a series of three machines, which had ample capacity for handling the stock at each operation. The same thing applies to the work of the scouring machine. He submitted the grain, in this instance, to two operations. By removing the material gradually on the separators, he took out nothing else than impurities; small particles of wheat and large grains were not removed. By the gradual process he was enabled to take out all of the impurities, but without removing as large a bulk of material as is usually the case where the operation is less gradual. He cleaned his wheat better, but removed a smaller bulk of material; he took out only such stock as should be properly removed, and did not remove that which properly belonged to the wheat, for which reason the bulk of stock was not so large as when the operation was more wastefully carried on. In the operation of the scouring machinery it is clear that better results can be obtained by a repetition of the process. Scouring machinery has been made, the operation of which was so severe as to break a large portion of the wheat in the effort to scour that portion which was not broken. It must be apparent to the miller that the best results may be derived by the repetition of a process which is not so severe as in the instance above mentioned. The best scouring of the wheat is acquired by a repetition of gentle means.

In the case of the miller who made this change, it may not be out of place to say that he made a difference in his yield of more than six pounds per barrel, and the percentage of low grade was reduced one-third of its original bulk. This was brought about from the fact that there was not so much low grade stock in his mill—he took it out on the cleaning machinery—and for the reason that such stock was taken out at that stage of the process, it is evident that a certain proportion was saved from going into a higher grade of flour, as the passage of this low grade stock from the head to the tail of the mill would of necessity imperil the intermediate grades of flour. It is difficult to emphasize sufficiently the benefits to be derived from the proper cleaning of the wheat.

It is a common expression in Hungarian mills that investments in

cleaning machinery always pay. This is said in the face of the fact that for many years the Hungarian mills have had the most elaborate and extensive arrangements for the cleaning of wheat. The above expression is still regarded in the light of an axiom, a self-evident truth. While the result of the cleaning operations by the Hungarian system is much more perfect and altogether more satisfactory than in American mills, such success is achieved, for the most part, through the number of machines used, rather than their excellent quality. With one exception, the American wheat cleaning machinery may be regarded as superior to that used in Hungarian mills. The exception named is the rolling screen, which is largely used in those mills. The American system of wheat cleaning, to say nothing about the machines, is very much inferior to Hungarian methods. In the Hungarian mills inferior machines are arranged on a superior system, and for that reason do superior work.

In those Hungarian mills where so much attention is paid to the cleaning of the wheat, it is thought necessary to grade it before submitting it to the action of the separators, and a little thought will show the logic of such a process. No one ever thinks of purifying middlings without grading, and while the difference as to the specific gravity of the wheat impurities does not suggest such fine distinctions, thoughtful observation will teach us that it will be well to grade the wheat into two sizes. This involves the use of a machine which has never been perfected—the wheat grader. The only thing which approaches it is the rolling screen. The trouble is the lodging of the wheat in the meshes of the wire. One of our successful firms who manufacture wheat cleaning machinery attempted to make a grader at one time which involved the use of screens. The wheat lodged in the openings, and, thinking to loosen it, they tried knockers; but the more they knocked the tighter the wheat was driven into the openings. They experimented not a little with graders, but never succeeded in making one which was satisfactory to themselves. The successful grader has never been made. Our Hungarian friends use the rolling screen in default of something better.

CHAPTER XXVI.

THE PRINCIPLES OF WHEAT CLEANING—SEPARATIONS—PRINCIPLES INVOLVED IN SEPARATING FOREIGN IMPURITIES—SEPARATION OF DUST—THE WEIGH HOPPER—WEIGHING OF WHEAT WITH REFERENCE TO DAILY YIELDS—THE ROLLING SCREEN—THE HORSESHOE MAGNET—THE SMUTTER—REMOVAL OF IMPURITIES WHICH ARE ATTACHED TO THE WHEAT—GENERAL PRINCIPLES OF CONSTRUCTION OF SMUTTERS AND SCOURING MACHINES—GENERAL ARRANGEMENT OF WHEAT CLEANING MACHINERY—WHEAT HEATERS.

In general terms the cleaning of wheat consists in the removal of all foreign material from the mass of grain, and the fibre and fuzzy exterior from the grain itself. The foreign impurities are the dust, sand, chaff and straw. Then there are numerous seeds--chit, wild onions, oats, corn and other foreign grain and seeds, as well as blasted kernels of wheat and rust, and ergot (smut.) In some parts of the country there is trouble from small bits of clay getting mixed with the wheat. There are always pieces of metal, such as nails, screws, wire, etc.

The principles involved in the separation of these impurities and foreign substances from the wheat are those used in taking advantage of the differences in form, size and specific gravity or magnetic affinity of the various impurities. The distinction as to form is taken advantage of by passing the whole body of material, grain and impurities alike, over a screen, the wheat itself going through openings which are adapted to its form. Particles of straw, sticks, chaff, oats, etc., are separated from the wheat by taking advantage of their elongated form. The wheat grains go through the screen openings, which are abundantly large for their passage, but, as the screen is inclined, each berry must be tipped forward in order to enter the hole. Each hole is of such diameter that when the wheat grain, sliding forward, carries its center of gravity beyond the support of the upper edge of the hole, it drops through. The oat grain, or other similarly formed substances, being longer than the wheat grain, will, for this reason, extend over the lower margin of the

hole before the weight of the lower end is sufficient to cause it to dip and fall through. Thus it passes over the end of the screen and goes off with the impurities.

Cockle and other round seeds which are of the same size as the wheat are also separated from the bulk of the grain, on account of the distinction as to form.

One of the earliest devices for separating these round seeds was the arrangement of a cone over a cylindrical hopper, the former being slightly smaller than the latter. The wheat was discharged at the point or upper part of the cone. The elongated wheat grains would slide to the bottom of and into the hopper with somewhat less velocity than the round seeds. These round grains, however, would slide down the cone with much greater velocity than the wheat and leap over the opening between the cone and hopper. This machine is not now in use, however. Another device consists of a cylinder of partially perforated or indented metal. This cylinder is kept in slow revolution. Within the cylinder is the trough, which is given a slow, shaking motion, and is inclined at an angle of about ten degrees. The indentations in the outer cylinder are of such a depth as to allow the small seeds to rest in them until the cylinder has revolved sufficiently to allow the small seeds to fall back, not into the cylinder itself, but into the rotating trough within, the movement and slant of which is sufficient to conduct these impurities into a separate spout of the screen. The form of the wheat berry does not allow it to imbed itself in the perforations or indentations of the cylinder sufficiently to carry it so as to fall into this trough.

The separation as to the size of the impurities is made by passing the grain over perforated screens, which allow the impurities that are larger than the wheat to pass over the end of the screen and the wheat to pass through the openings. From thence the wheat passes to other screens, with openings smaller than the wheat itself and through which the smaller impurities pass.

The separation on account of the specific gravity may be best described by considering that specific gravity is the ratio of weight of bodies of equal volume to one another when taken in connection with a standard. Bits of chaff, straw and dust are of less specific gravity than wheat; that is, the same volume of such articles weighs less than the wheat itself. The separation on account of specific gravity is made by passing the entire volume of wheat through currents of air adjusted

so as to remove all particles of less specific gravity than the wheat itself. Aside from the dust and chaff, various seeds and impurities, which are of the same form and size, though of different weight from the wheat, are removed.

To consider the wheat cleaning operations in more practical form, we may say that there is no reason why a certain amount of dust should not be taken out of the wheat as it is unloaded, and before it is weighed. It could make no appreciable difference in the weight, but it would make an appreciable difference, not alone to th se who have to do with the weighing, but with the subsequent cleaning as well. Weigh hoppers and their surroundings are for the most part disgustingly dusty and dirty. More than one man has sacrificed his life by working in this part of the mill. If the weigh hopper be in the hopper, as is usual, a great deal of the dust could be taken out by merely placing a hooded suction opening over the shute. A more elaborate way would be to close the top of shute near the mouth in such a way as to get the full benefit of the suction. This same arrangement is applicable to mill hoppers placed at the top of the building.

Following the wheat from the weigh hopper, it may be said that it would be well to remove dust therefrom at every stage in its course possible, by suction attachments under the weigh hopper connecting with the spout which leads from it, and, in case of the weigh hopper being below, so that the wheat has to be elevated before being discharged into the bins, nothing better can be done than to make a suction attachment at the foot and particularly at the head of the elevator. All of this can be inexpensively done, and at the same time that it removes the dust from the wheat, it keeps the obnoxious material out of the mill.

It is highly important that arrangements be made to weigh wheat after as well as before it is cleaned. Such an arrangement indicates the exact loss in cleaning and tells the story if there be anything unusual. A weighing apparatus which makes it possible to weigh each day's supply of wheat separately, enables the miller to take a yield every day, than which there is nothing more satisfactory.

After the weighing of the wheat, it might be passed over a rolling screen, on its way to other cleaning machinery. The rolling screen is one of the best pieces of machinery which was ever put into a mill, but of late years it has been sadly neglected. It went out of use as the new process came in; it died because of its earlier associations. It takes up a

great deal of room—is not very pretty to look at—but it is a fairly good separator, and somewhat of a scourer at the same time. With a suction fan attachment, all of the dust in the wheat can be taken out. The separations are made, as is known, by the size of the meshes of the cloth, the screenings and small seeds going through the head cloth, the wheat through a coarse wire cloth at the tail, and the straws and larger foreign material over the tail. The scouring influence spoken of is caused in the passage of the wheat through the reel by the friction of the wire. This scouring on the rolling screen must not be underestimated. It is not sufficient, however, but is just the kind of scouring which will not injure the bran, nor mutilate or waste the wheat. If it did not involve so long continued an operation, this method of scouring would be an ideal process. As to the taking out of the dust, we all know that this is simple enough. A strong current of air through the reel, preferably from the tail, will do the work.

A rolling screen with a most excellent scouring action may be made by using a wire clóth made with square wire rather than round. The edges of the wire present a most excellent scouring surface, the severity of which could be regulated by the speed of the reel as well as by the arrangement of the ribs or lifting surfaces on the inside. By reducing the effectiveness of the latter, the amount of scouring action might be largely reduced, and by lessening the speed, the scouring action would also be diminished. The general principle of the construction of rolling screens is understood, and, for that reason, it is hardly necessary to enter into a detailed mechanical description.

The following is from a correspondent regarding this screen, and is submitted for general consideration: "Its utility or adaptability can be nothing more than speculative, as the experiment, as far as the writer knows, has never been tried. The suggestion was to have a reel into which the grain might be spouted and which would revolve for some minutes in it; that is, the supply of wheat would be run into it and then cut off, while the reel would revolve with this wheat in it for any desired period. This feature would be somewhat similar to the manner of operating a hominy mill; it would be charged with grain, and after it had been in the reel long enough, it would be discharged. It would have to be arranged so that the reel would be level while the grain was in it, and pitched at a time when a discharge was desirable. Again, it was suggested that there might be automatic arrangements for supplying the reel with the proper quantity of grain."

It is easy to see that the grain, when run into a reel clothed with wire and retained there for a time while it was in motion, would be well scoured. There would be the friction of the grain against itself and against the wire and ribs, which operation would not be so severe as to, in any way, disturb the bran coating. In fact, the severity of this operation might be regulated in many ways. We know that there are means of reducing grain by attrition, by the force with which it is propelled against any hard surface. This is the extreme of a movement of this kind. Again, we know that the grain might be put into a reel with a smooth inside surface which revolves slowly, and which would have very little effect upon the grain. Here are the two extremes.

The object in charging a reel and allowing the stock to stay in it for a time is to increase the duration of the friction, but not its absolute severity. Smutters and scouring machines, as ordinarily arranged, may be either too severe or not sufficient in their operations. It is desirable, by most millers, that the work of wheat cleaning be done quickly, without great expense in money or time. In the effort to make machines of great capacity and apparent efficiency, many of them are too severe. One or two scouring machines, where the wheat merely passes through them, must of necessity act harshly if they appear to scour the wheat; or lightly or inefficiently if they are not severe and yet are hasty in their operation. A miller could scour his wheat as much or as little as he pleased by controlling the length of time that it was in the reel and, at the same time, not injure the bran.

In any cleaning operation a certain proportion of the outer layer of the four layers of the bran coating will be removed. Attached to this bran layer and the next one are the vegetable hairs at one end, and the scale surface over the germ coating at the other. Wheat cannot be said to be properly scoured until both the vegetable hairs and this scaly substance at the other end of the berry are removed. The wheat, after being properly scoured, will show a round end with a crease through the centre, instead of the elongated form which was given it by the vegetable hairs. Work of this kind, when done thoroughly, is frequently done at the expense of a large amount of broken wheat and lacerated bran coatings. The less severe methods do little or nothing in a proper way. These latter methods, if repeated, or if they could be made to operate on the wheat during a longer period, would be the most efficient and satisfactory. The method which contemplates the charging of the reel

in the way described would necessarily require more machines than the usual way of scouring wheat, but the cost, certainly, would not be proportionately greater, either as to plant or as to the power required in their operation. These machines would probably require more space, though not a great deal more. The operation would not have to be repeated. The miller could arrange to keep the wheat in the reel until it was scoured. Thus there would be only one operation, though there would probably have to be two or three machines to do the work of one, as to capacity as estimated by the amount of stock required in the mill. That is saying nothing about the quality of the work.

One of the most positive separations which is made in the cleaning of wheat is by the use of the magnet. It was brought prominently into use immediately after the introduction of wire binders, and it was found that even with wheat, in the harvesting of which self-binders had been used, the proportion of wire removed was by no means the largest quantity of metallic substances which were taken out. Whether the magnets be of the ordinary horseshoe form, or the very neat and effective mechanical arrangements known to us all, it is well that they be used before the wheat goes to the separators or rolling screen and again immediately previous to its entrance to the first reduction bin. Magnetic separators are so inexpensive that a miller can well afford to be somewhat prodigal in their use.

The impurities which are attached to the bran are the vegetable fibre and hair, which are a natural part of the growth of the wheat. Such impurities, and the smut, which is of the same size and specific gravity as the wheat itself, are removed by the smut and scouring machine. The impurities which are attached to the bran should be removed without disturbing the general bran structure itself. The attempt was made some years ago to entirely remove the bran from the exposed surface of the berry previous to its reduction. Machines for doing this work were called decorticators, the idea being that if the bran could be removed the wheat might readily be reduced and the flour bolted without getting into it the usual proportion of bran particles. But the result was exactly the opposite; there was a larger proportion of bran particles in the flour and middlings than ever before. Instead of improving the flour and middlings, the decorticating effort largely depreciated the value of the milling product. In practice only a part of the exposed bran surface was removed, and that part which was in the crease of the berry

could not be touched. As a matter of practice it has been developed that any effort at wheat cleaning, or any preparation of the wheat previous to its reduction by reduction machines, which breaks or disturbs the bran structure, is a detriment to the product of the mill. It is important that the bran be allowed to retain all of its natural strength and toughness, so as to resist the pulverizing action of the reduction machine. In scouring wheat by the ordinary methods it should be remembered that only a mild polishing of the bran surface and the removal of the fibre therefrom is desirable, and that anything which attempts to go further than this is seriously objectionable.

As to the general construction and operation of smutters, it may be said that the principle of their operation is the same in all, the idea being to remove the attached impurities by friction; and the only difference in the construction of the various machines is in the variation of the mechanical arrangement for submitting the wheat to this friction or scouring action. They are all constructed with the same mechanical idea of a cylindrical perforated surface with internal revolving friction surfaces. With the latter the variation is in form, material and arrangement of parts. There are blades and round beaters; there are discs and revolving feeders, or surfaces, which rub the particles of grain together and against the jacket and the feeders themselves. As to the material out of which these various friction surfaces are made, there is iron, wrought and cast; steel, stone and brushes. This material is arranged in the form of discs of the various materials, which revolve against one another and which are arranged horizontally, they being arranged so that in some instances iron and stone operate together, and in other instances iron and the brushes. Then again, there are the vertical revolving brushes, both open and solid, and there is also the combination of vertical beaters and brushes. There are machines of somewhat different construction which hold the wheat in the jacket and rub the particles of grain one against another, feeding it out at the bottom in such a way as to keep the jacket above partially full of grain at all times. This arrangement causes the jacket to serve as a magazine receiver which retains a charge of grain within it at all times.

The jackets themselves vary somewhat in construction, being made, for the most part, of perforated steel, though wire netting and surfaces with interior protuberances is used on some of the machines. By the operation of the various friction devices, the attached impurities of the

wheat are separated therefrom and the suction draws such particles through the jacket and forces it from the machine. At the same time that these impurities are removed, the particles of smut and brittle grains are broken, which operation makes the particles lighter, and changes the gravity, so that they may be drawn out by the suction. All scouring machines perform the same general office of separators. The wheat is submitted to a suction before going to a machine, during its passage through it and finally as it leaves it.

It is well known that smutters are regarded as one source of danger from fire in flour mills, owing to the liability of the beaters to strike fire by coming in contact with pieces of metal. This can be entirely obviated by the use of phosphor-bronze in the construction of the beaters and jackets. The beaters and pickers of the cotton mills were formerly a great source of danger, and caused the destruction of many factories in that way. Since the introduction of phosphor-bronze, losses from that source have been reduced to a minimum.

Before leaving the question of wheat cleaning we will consider, in short form, the general system of arrangement which may be ordinarily used. First, perhaps, the magnets for removing metallic substances, after which the wheat may pass through a rolling screen that will do a certain amount of scouring, and which will also remove all of the larger and coarser impurities and a certain amount of the screenings. Then comes the separators, which remove a certain other proportion of the foreign impurities, including a large volume of the screenings and dust. From the separators the wheat goes to the cockle machines, which remove the round seeds and small broken particles of wheat. In order that the proportion of the latter may not be too large, it is preferable to have the cockle machines come after the separators rather than after the scouring machines, as in the latter event all of the wheat broken by these machines would be taken out by the cockle machines, which would be a great waste. There are arrangements of cockle machines which have, as a part of the same machine, a separator—a very compact and economical arrangement for small mills. Of all machines used in connection with the wheat, none are more wasteful and at the same time more inefficient when overworked than the cockle machines. In certain sections of the country cockle does not grow in sufficiently large quantities to justify the use of the machine for making these separations.

After the grain leaves the cockle machines it passes to a scouring ma-

chine of a more severe type, which removes, by suction, certain foreign impurities which were not taken out by the separators, and which also detaches the fibrous impurities from the grain and disintegrates the softer and smut particles which are taken out by a suction fan. Following the smutters and scouring machines of the more severe type are the brush machines, after leaving which the wheat is taken to the bins, where we will leave it for the consideration of the subject of wheat heaters and artificial moistening apparatus.

After the wheat has left the cleaning machinery, and before it goes to the reduction machines, it may pass through steamers and heaters. In some parts of the country it is found necessary to wet the wheat before it is reduced, on account of the brittle nature of the bran. Because the wheat is dampened it does not follow that the flour or middlings will be damp. The process is so timed that, while the wheat will be uniformly moist, the moisture does not have time to enter the body of the berry and affect it wrongly; it simply toughens the bran. The wetting of the wheat is accomplished oftentimes by a conveyor which thoroughly mixes it, and from whence it goes into a bin, to remain long enough to become uniformly and duly moistened. The advantages to be gained by toughening the bran by moistening the wheat either by steam or water, or by drawing the moisture from the centre of the berry by heating, is one of degree. It will be appreciated most where the wheat is most brittle. It will have a beneficial effect upon any wheat, most beneficial, of course, where the bran is least tough.

Excepting in exceedingly dry countries, or where the bran is extremely dry and brittle, the heating of wheat will usually bring a sufficient amount of moisture from the interior to the exterior of the wheat to toughen the bran and do all that may be done for it in this way.

A wheat heater will not make tough wheat dry, nor dry wheat particularly tough, but it does have a quality of bringing about a more uniform condition of the stock. As far as is known, there is no condition of the wheat, if it is at all suitable for grinding, but that its product will be improved by its having been passed through the heaters. The bran will be larger, the flour clearer, the middlings rounder and freer from the bran specks, and more easily purified on that account; the flour more easily bolted, because of its freedom from the contaminating influences of the impure material.

There is a smaller proportion of middlings from wheat thus treated

which has pieces of bran attached. This is because the bran is less brittle, coming off in larger pieces. This is one reason why the middlings are more easily purified, and it is a very good reason why there is a smaller proportion of tailings from such middlings. Probably every miller has noticed that the proportion of small bran particles and other undesirable stock is much less with tough wheat than with that which is extremely hard. Wheat which has passed through heaters has the virtue of being dry on the inside and tough on the outside. It will always be noticed that such wheat feels a little damp. Now, there is no place for this dampness to come from except from the inside of the berry, and if this dampness or moisture is perceptible on the outside of the grain, it cannot be present to so great an extent on the inside. Hence, it is reasonable to suppose that the part of the wheat which it is most desirable to reduce—that is, the inner portion—can be most readily reduced, and that the exterior, which it is desired not to reduce, is tougher and less susceptible to the action of the reduction machinery—a very desirable condition of things.

CHAPTER XXVII.

FIRST BREAK—WHEAT GRADING FOR GRINDING—GRADING OF WHEAT ON ACCOUNT OF HARDNESS OR SOFTNESS—WHEAT MIXING—PURPOSE OF WHEAT MIXING—MACHINERY OF THE FIRST REDUCTION—FIRST BREAK SCALPER—FIRST BREAK FLOUR—CREASE DIRT—THE SCOURING ACTION OF THE FIRST BREAK SCALPER—FIRST BREAK AS PREPARATORY TO MIDDLINGS MAKING—CLOTHING OF THE FIRST BREAK SCALPER—CLOTHING OF THE FIRST BREAK FLOUR REEL—FLOUR FROM THE FIRST BREAK—PROPORTION OF FIRST BREAK FLOUR.

As suggested by the foregoing chapters, it is the purpose to take a look through the mill, taking each reduction and the separating machinery which immediately follows it, and making such observations and notations as such a course would naturally bring out.

Before taking up the wheat where we left it, it will be in order to consider the matters pertaining to its grading or mixing previous to its reduction.

There has been a great deal of talk about the grading of wheat. It has its theoretical and practical advantages. There are small and large grains of wheat in a general mass, and it is only the larger grains which receive the benefit of the first reduction. If the rolls are set properly for the large grains, they are too open for those which are smaller, or if they are set properly for the small grains, the large ones are reduced too much. If there is a compromise, none but the medium sized grains are properly handled. There are very few mills that are carrying out this idea of the grading of wheat previous to its reduction. There are few millers who do not recognize good reasons for so doing. The greatest practical obstacle in the way of accomplishing this result is that the successful grading machine—the one that is generally recognized as being successful—has not been made. The great difficulty is in keeping them from clogging. Whenever this is gotten over, the grading of wheat will be more common in mills which employ more than one pair of rolls for the first reduction. It is not necessary to carry the division of stock

made necessary by the original difference in size further than the first break. In any event the first break is a sizing operation.

On the same line it may be well to say that it is theoretically wrong to mix wheat for grinding, though it is for the most part a practical necessity. At one time the following expression was made use of in this connection: "Of all the unreasonable, pernicious practices in milling, that of mixing wheat is the most to be wondered at. If a miller knows what he wants most, he knows that he wants wheat of a uniform texture; that is, uniformly hard or soft. * * * * Flour mixing is all right, and wheat mixing all wrong." This is all right; but there are circumstances which compel the millers to mix wheat previous to grinding. The mixing of flour in a mill in exact proportions is not a very simple matter, and there are many millers who always see fit to grind hard and soft wheat together. For instance, in the winter wheat country it may often be desirable to mix in a certain proportion of hard, small Kansas wheat, which, by the way, makes most excellent flour, with a certain other proportion of round, soft Fultz wheat. Now, in the grinding on the first break, many of these small grains will not be touched unless the larger grains be very much lacerated by the close setting of these rolls. One way out of this difficulty where there are at least two pairs of rolls on the first reduction, is to grind the small, hard wheat on one pair of rolls, and the Fultz wheat on the other. This would involve a division in the first reduction bin so that the hard and soft wheat could be kept separate previous to grinding. Each grade could be smutted separately; that is, at different times. In this way the two grades of wheat, after passing through the rolls, would run together, and further on in the process of manufacture they would continue together. But this separate grinding on the first break will partially mitigate the evil of handling hard and soft, large or small wheat together. It is a fair venture to say that there is more mixing of wheat both in the spring and winter wheat sections at this time than ever before. In the winter wheat region it is the mixing of hard and soft winter wheat; in the Northwest it is the same thing with the different varieties of spring wheat, and in both instances it is brought about by the scarcity and superiority of the harder varieties. Notwithstanding that the mixing of wheat is not exactly the thing to do, it will be done a great deal more than the mixing of flour after its manufacture. The mere mixing of one product with another is usually done in this country with a conveyor,

which is quite efficient. In Hungarian mills, and in a few mills with us, it is done by a revolving disc under a stationary one, each having wooden pins projecting from each surface.

To take up the first break: The express purpose of this break is to split the wheat in order to release the crease impurities. The writer will say that he has never seen a reduction machine which did this thing with any degree of completeness. It is fair to say that a good proportion of the grains are split, but not all by any means. There are many grains with the backs and ends knocked off and many which are cut lengthwise, but there is not that proportion of wheat which is split through the crease that is desirable. However, this end may soon be reached, as very many intelligent millers and mill builders are working for a better first break machine.

With roller machines there are means and arrangements for the express purpose of making a satisfactory first break. The writer has lately heard of two rolls with very coarse corrugations, say two to the inch. Then there are machines with one of these coarsely corrugated rolls running against a smooth roll. The experiment has been tried of running sharp cut rolls of the ordinary corrugation—eight to the inch—at integral motion; that is, both at the same speed. The more common way is to run such rolls two to one, the sharp part of the corrugations together. A very fair break with sharp cut rolls can be made by running the dull backs together. This can be done by running what is ordinarily intended for the slow roll, fastest.

It is a common expression that the iron disc machine makes the best first break, but while this may be so, it is also true that it makes more flour than is made by rolls.

A miller described to the writer a machine which was tried. It was a form of disc machine similar to the Jonathan Mills, but different in dress; it had furrows, in form thus . There was no draft except a very little at the skirt. He said that it worked very well—split the wheat—but made entirely too much flour.

A satisfactory first reduction by any machine can never be made unless the wheat is graded, for whereas, four corrugations to the inch is the proper number for the largest grains of wheat, or for wheat as it goes on to the rolls in an ungraded condition, it is fair to say that smaller corrugations—say six to the inch—should be used for smaller wheat. This is where smooth and corrugated rolls run together.

After the stock leaves the rolls it goes to a reel clothed with 18 and 20 wire. Sometimes a sieve has been used; but whatever preference one might have for a sieve elsewhere, it cannot be said to have a place as a first break scalper. A reel three feet long will make a complete separation for a 500-barrel mill on soft winter wheat, and one two feet long would do the same thing on a 100-barrel mill, though it would not give the scouring and detaching action which was mentioned in connection with this reel. Two feet might be a little short where the wheat is spouted into the reel in such a way that it does not discharge close at the head, but it would be safe to say that where the stock has full benefit of the two feet of reel, it would no doubt do its work well as to scalping, but would do little scouring.

The motion of the reel is inclined to assist the work of the rolls in that it will separate the pieces of wheat that remain together after leaving the rolls, and which have not been entirely broken thereby. This is one place where the work of a disintegrator is useful, and a reel answers this purpose very well. It completes the unfinished work of the rolls; it jars the pieces of wheat apart and liberates the crease impurities, as well as the middlings. Some one advises the use of a centrifugal reel for this purpose, and there is mention made of where such reels have been used as smutters, covering them with steel wire cloth.

It has been questioned many times whether the flour from the first break was really of the objectionable character usually attributed to it. An examination of the flour certainly ought to settle this question. We know that it makes a muddy, black dough, without any of the qualities of good flour. As to the seam dirt, the writer is inclined to think that it is there, the form of the receptacle being such as would retain dirt and dust. It is certainly such as would render it difficult of access by the ordinary cleaning machinery. If it is desirable to scour the more accessible portions of the grain, it is certainly desirable that those less accessible should be treated in the same way, in so far as it is economically possible. It is possible in so far as the first break will split the wheat, and the first break scalper will scour it. The splitting of it, and the general disturbance of the berry by being crushed, is calculated to release the crease or seam dirt when it is first submitted to the action of the reel. The first break scalper is a good deal like a rolling screen. It screens and sifts the wheat after it has been submitted to the first reduction rolls. For this it is a most valuable machine. It is a scourer to a

great extent in the nature of its construction. On account of this scouring action the flour made by the first break rolls and in the reels will be bad. The scourings go into the first break flour and the quality of this flour indicates the action of the first break scalper as a cleaning machine.

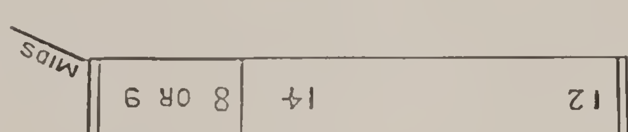
Aside from the merit of the first break operation, as here suggested, there is the additional merit of its quality as a preparatory machine. Even if it did not remove any of the dust or bad flour, or that the first break scalpers did not scour the wheat in any degree, in fact that there was no immediate result from its use, it would still be a necessity for gradual reduction milling; it would be a necessity as a reduction machine. It splits and breaks the wheat in a way suited to the action of the subsequent reduction machinery. The second break does the same thing in a measure. After the wheat has been broken and split in the coarse way that it is by the first break, it is then possible for the finely corrugated rolls to reach the stock in a way to separate the flour and middlings therefrom. This is a merit of the first break machine which has not always been appreciated, and the more it is thought about the more it will be appreciated.

All this suggests that a reel slightly longer than is absolutely necessary to make the separations might do good work as a scalper for this break. It would knock loose a good deal of dirt, and continue the work of the wheat cleaning machine in a mild way. This idea is used in the dismembrators, and in various other machines in connection with the reduction.

In a previous chapter mention was made of the relation which the corrugations bear to the clothing of the scalping reels. The size of the middlings is determined in a large measure by the size of the corrugations, and as it is desirable to take out the middlings as fast as they are made, the reels should be so clothed that they will not carry over middlings from one reduction to another. It is fully developed that No. 20 wire cloth will not carry over middlings to the next reduction, when rolls with ordinary corrugations are used on whole wheat. This, of course, covers its use on the first reduction. At the same time that No. 20 and 22 wire will not carry over middlings as mentioned, any finer number would. No. 18 wire is used a great deal on the first break, but the middlings which go through such a number are equal to those of No. 0000 silk, and there are very few mills which have facilities for taking

care of so large a grade of middlings. It is embarrassing and unsatisfactory to try to do anything with them when mixed with smaller middlings. In truth they are very lumpy, being ends of wheat or small bits of middlings with large adhering portions of bran, which bran determines their grade rather than the middlings themselves. If one were to examine middlings which pass through a 0000 cloth, he would see a very small proportion of pieces which did not have adhering portions of bran. In fact, such bran gives color and character to the whole product. Adhering bran is the rule and not the exception. They are nubs rather than middlings.

The product of the scalping reel, which is flour and middlings, is usually and preferably cared for by itself. By this is meant that the flour is bolted and sent to the packer and the middlings sent to their proper place in the mill for the purpose of grading and purification. The work of taking care of this product is often done on two reels, but still more frequently on one. The reel is clothed, when only one is used, in many instances as shown in the accompanying cut.



The product of the flour cloth is low grade. The cut-off of the flour cloth and the product of the No. 8 or 9, is a low grade of dust middlings, which makes a low grade of bakers' flour. The tail of this reel is good middlings, which may well be sent to the grader. When two reels are used, the middlings should first be scalped over an 8 or 9 cloth, and the flour cloth on the next reel below. Oftentimes the product of the scalping reel as mentioned, i. e., that clothed with No. 8 or 9 cloth, is sent with the sixth break stock to be bolted. This is objectionable because, as a general thing, the flour is poorer from the first than the sixth break, and further, because the middlings which will go through a No. 8 or 9 cloth are a better grade in the case of the first break than is the case with the corresponding or larger middlings of the sixth. The flour from the first break varies in quality with the same grinding and the same general grade of wheat. Winter wheat immediately after harvest makes better first break flour than later in the season. This is the case even though the wheat be quite dry and hard at the beginning of the crop year. Soft wheat makes better first break flour than hard wheat.

There is really a very small proportion of flour made on this break. When gradual reduction methods were first introduced, we were led to

believe that 3, 4, and even 5 per cent. of the break flour was ordinarily made at the first reduction. By grinding ordinarily close, 1 per cent. of flour is more than is usually made in this part of the mill. The proportion of flour made by rolls with corrugations as coarse as those here used is not in the ratio of their close setting when grinding. It is not possible to make a very large proportion of flour with such coarse corrugations.

Various methods of arranging first break machines and the reductions which follow will be indicated in the practical operation of such machines and their following uses in the mills of specified sizes, which will be considered in future. In that way the methods which are adapted to the various sized plants will be properly understood and properly followed up by the subsequent operations.

CHAPTER XXVIII.

SECOND REDUCTION—PROPORTION OF FLOUR FROM THE SECOND REDUCTION—ZINC FOR CLOTHING SCALPERS—PROPORTION OF BREAK FLOUR—DRESS OF SECOND BREAK ROLLS—SCALPING FOR THE SECOND REDUCTION—ASPIRATOR FOR REDUCTIONS—RUNNING OF THE SECOND BREAK ROLLS WITHOUT A CHANGE OF FEED.

After the stock leaves the first break scalper it frequently goes through an aspirator on its way to the second break machine. These aspirators are constructed like the aspirating middlings purifier, though they do not need to be so fine in adjustment. This machine may take out a little light bran, though very little, not much of it being detached during the first reduction. But if there should be any wheat which had not been separated from the heads or chaff in threshing, the first reduction will complete this work, and the aspirator will draw out the white caps But really there is not a great work for the first break aspirator to do, the reduction not being severe enough to detach any of the impurities of the wheat which would not go through the scalper.

The second break operation is a middlings making as well as a preparatory process. Very little flour is made by the rolls on either the first or the second breaks. More flour is made in the reels and elevators than on the rolls. This matter is deserving of careful attention. As a middlings making process, every detail of gradual reduction should have in mind not only the making of middlings, but the means of preventing the making of break flour during the process of wheat reduction. As there is no difficulty in making the flour and middlings separation from the second break stock, it cannot be seen why a sieve separation would not be possible. The position for such sieves might be under the rolls, to avoid the use of elevators, and hence little flour is made in this way. Zinc is being used to some extent instead of wire for clothing all scalpers following the first break. It can be recommended for general use.

Considerable has been said about the second break and its importance as a milling operation, not exactly on account of its value in its

production of middlings or flour, but in a preparatory way in getting the stock ready for the third and fourth breaks. Because the results of the second break are not apparent during the immediate course of, or in connection with its operation, it is not deserving of neglect. It is a matter of the greatest importance that the grinding by the second break rolls be attended with great care, as the whole product of a mill is largely influenced thereby.

We often see tables wherein the exact proportions of flour and middlings made by the various breaks is given with the strictest regard to accuracy of expression. Figures are given, including two and three decimal points, indicating that the weighing and measuring has been done in a very scientific manner. Excepting in general terms and in a general way, the writer has never been able to determine the quantities of flour made by the various breaks. He has never done any weighing or measuring for the purpose of informing himself, and cannot think that the figures which we see given for the purpose of determining the quantities of flour made in this way can be of practical service, as there must be a great deal of variation with the different kinds of wheat, and with the same wheat under different conditions and circumstances. In one mill the break stock may drop into a conveyor and be carried some distance before entering an elevator that conveys it to a scalping reel, which may be somewhat longer than necessary. The conveyor, its length, the elevator, the spouts leading therefrom, the reel and its construction, may be largely instrumental in influencing the proportion of flour made by the breaks. Thus a miller may be doing just as good work on the rolls, independent of the other devices, and yet if he were to take the pains to determine how much break flour he was getting through the reels from a certain break, it would be shown that he was not doing satisfactory work, when compared with the standard set forth under more favorable conditions. The proportion of grinding surface on the rolls, their speed, the dress, all largely influence the proportion of flour made; and as there is such a great variation in all these things, and as millers are operating under such a variety of conditions, it is difficult to see how they can be greatly benefited by the elaborate exhibitions which are the result of ideal conditions, and which are expressed in a very scientific way.

Any one who has ever done any sifting for the purpose of making experiments, knows how deceitful that process is. He knows that he

can always get better results with a hand sieve than he can get with the reels in his mill in a practical way. Take the sixth break, for instance. By sifting the stock one can get some very brilliant flour, yet as it comes from the reel it is far from brilliant. It may be white enough from winter wheat, in the dust, but it is very red in the dough. In sifting the second break one finds very little flour, and that of questionable quality. The flour from the second break does not look as well as that from the fifth. The middlings, however, are of good quality, both as to general appearance and form.

Some time since the writer made up his mind that ten corrugations to the inch was the proper thing for the second break, and having used both ten and twelve, is still persuaded that the former is the best. Such a corrugation cannot make a great deal of flour, no matter how close the grinding; and whereas, it is not desirable to grind close on this break, there are circumstances which demand closer work one time than another, both in the first and second breaks. This is when the wheat is soft. The first break is more of a purification than the following wheat breaks. The second break makes large, heavy middlings, and a small proportion of flour. The grinding on these two breaks has a great deal to do in influencing the quality of the work done on the subsequent breaks. When the wheat is soft, as intimated before, it requires that the grinding be closer in order that the third, fourth and fifth breaks may not have so much to do that they will make soft, flat middlings.

The scalping reel for the second break should be one-third longer than that for the first. An eight-foot reel will do the work on a 500-barrel mill. Three or four feet will do for a 100-barrel mill. The length of the scalping reel for any break is dependent upon the proportion of soft stock going into that reel, and for a mill with four breaks which makes 100 barrels of flour per day, as is often the case, longer scalpers would be required than are here specified. Owing to the greater amount of work required of each reduction, and consequently the larger proportion of flour stock made, a larger reel would be necessary. It is quite common to build scalping reels all in one chest, and consequently all of one length. There cannot be good reason for this, as a reel which would be long enough for the third or fourth break would be too long for the second and not long enough for the fifth or sixth. Or, if they were long enough for these breaks, they would be too long for the others, and as has been said before, it is nearly as important that the scalping

reels after the first break should not be too long as that they should be long enough. If too long, they would whip through fine bran and other impurities at the tail, besides making flour in the reel.

As a ten corrugation will make a good many 000 middlings, and as 000 middlings from the second break are bright, if of good quality, it suggests the clothing of that scalping reel with No. 20 wire cloth, which was the same as used for the first. One might say that if a second break with ten corrugations requires a No. 20 wire cloth on the scalping reel, the eight or coarser corrugations of the first would demand coarser than 20 wire for the first break. It would if coarser middlings than the 000 were desirable in the mill. The 0000 middlings, which would be equivalent to those of an 18 wire, as said in the foregoing chapter, have large adhering portions of bran, and are not of a quality readily disposed of in the manner usual with middlings. No. 20 wire was used for the first break on this account, but if the natural demand of the corrugation had been considered, without reference to the quality of the middlings, 18 wire would have taken its place. No. 20 wire is the natural demand of ten corrugations, and as the product of middlings from that number is desirable, it is so clothed. The product of the second break is bright, clean stock when the preceding first break has been run sufficiently close.

Two or three years ago, when the stock from the various breaks was under discussion, a miller was advised to bolt his third and fourth break chop together after leaving the scalper, and the second and fifth by themselves. This was in a large mill, where it was possible to do this if there was any advantage to be gained by such an arrangement. This was not right. If there are to be any divisions at all of this kind, as there may profitably be in a large mill, it does not want to be done by running the second and fifth break stocks together. As a matter of fact, there are no two breaks which are alike. The third and fourth are the nearest, but the others are widely different one from the other. It would be better policy to handle the second and third break together than it would the second and fifth. But the second, third and fourth are near enough alike to be handled together in separating the flour and in the purification of the middlings. This part of the description will be handled later. The flour from the second break is white and granular. It has a rounder, sharper feeling than that of any other break.

The stock passing over the tail of the second break scalper goes to

the third break, of course. In some instances it passes through an aspirator. The idea of an aspirator is to take out the light, fine stock, and thin, fly-wing bran which may be detached during the process of reduction. In the later reduction there may be some finished bran to be taken out, which, if continued to the end, would be cut up and thus be injurious to the flour made by these machines. In fact, this would be the case in the reduction of any of the impurities which were specified as being such as it was desirous of taking out by the aspirators. These machines are nothing more or less than purifiers. They take out the impurities which are of less gravity than the unfinished break stock. They remove the stock which should not go in with the subsequent breaks. They take out unfinished feed which would otherwise be pulverized with the flour. But there is another side to this question; at the same time that they take out these impurities they draw out flour and mix it with the undesirable stock, or blow it into the dust room. One might say that there should not be flour in the stock which tails over the scalpers to go to the aspirators. But the fact of the stock showing clean as it leaves these reels does not necessarily imply that it does not contain flour in a shape to be taken out by the aspirators. The unfinished break stock may have this flour inclosed in the various particles composing that stock, and which was not disturbed or knocked out in the reels, but when submitted to the action of a suction fan, will come out in surprisingly large quantities. One of the purposes of a dismembrator is to open up the stock and make the separation which is not made in a common reel.

Here again comes the query whether or not the dismembrator or agitator does not mix a dangerous proportion of the impurities of the wheat with the flour and middlings stock. As opposing the idea of a dismembrator or even the action of a reel, is the sieve scalper, which is certainly the gentlest means of making a separation. The Smith Purifier Co. formerly made, and may be making now, what they call a break purifier. The idea was certainly a good one as they arranged it. After the stock left the rolls it first went through a reel to take out the flour and finest middlings, say that which would pass through a No. 3 or 4 cloth. The part which tailed over this reel went onto the break purifier mentioned, which is similar to the Smith Middlings Purifier, though not so elaborate in detail. This machine aspirates and grades the coarse middlings at the same time it takes the impurities formerly mentioned

from the stock which goes to the next reduction. This is a good scheme and ought to work well if properly arranged and worked out.

A miller with whom the writer was talking several months ago, said that he never changed the feed gates on the second reduction, as he changed it on the others to conform with this. His idea in so doing was that, by such a plan, he was enabled to keep a uniform feed on the mill, by sizing the wheat on the first break. The writer does not believe that this result would be accomplished in this way; and, in the second place, does not think it desirable to try to do it. The uniformity of the feed on the second break machines would be dependent upon the uniformity of the grinding upon the first, and it is not desirable that the grinding should be uniform on the first break. Certain conditions of the wheat demand closer grinding, and certain other conditions demand relatively higher grinding. To make the grinding on the first break conform to the set of the feed gates on the second break rolls, is going out of the way to accomplish something that is not desirable even if it were attainable. One does not want a uniform feed on the mill. There are certain times when it should be relatively light, and certain other times when it should be heavier. For instance, with soft wheat it may be desirable to run a light feed and with hard wheat a heavy one. The tail end of the mill will prompt as quickly as anything in this matter.

This miller said that closer grinding on the first break would naturally reduce the feed on the second, and consequently demand that feed be taken off the first break machines, and in this way compensate for the effects desired, because of hard or soft wheat. With this view of the case it is presumed that the low grinding on the first break, because of the wheat being soft, would reduce the feed on the mill enough to make the bolting all right because of the stock being softer; that is, the demand for low grinding at the head of the mill would cut down the feed enough to compensate for the demands of a light feed further on in the processes of separation. But this sounds and looks altogether too nice to work out. It is these acute, elegant ideas that are liable to lead people astray. There would be more frequent changes under these circumstances on the first break, and less radical changes of the feed on the breaks following the second. The closeness of the grinding, as said before, would make a lighter feed all the way through, and as such

grinding would be demanded on the first break by soft wheat, this diminution of the volume of stock would presumably make relatively closer grinding where least desired with this kind of wheat; that is, on the breaks following the second. On the whole, it does not appear profitable to follow arbitrary rules in regard to these matters.

CHAPTER XXIX.

THE THIRD BREAK—CORRUGATIONS FOR THE THIRD BREAK—THIRD BREAK SCALPER—FOURTH BREAK—CORRUGATIONS—SCALPING REEL FOR FOURTH BREAK—FIFTH BREAK—CORRUGATIONS—QUALITY OF THE FIFTH REDUCTION STOCK—FIFTH REDUCTION MIDDLINGS.

The third break stock is the summit of excellence of the break stocks. The descent in quality is both ways from this break—to the first on one hand and the sixth on the other. The use of this pyramidal form of illustration is all right as applied to the third break, but if it could be construed to mean uniformity as to the first and sixth, it would be incorrect. The first break is not so good as the sixth; the second is better than the fifth and not so good as the fourth. Thus the ascent is not uniform in both directions, either numerically or in quality.

The stock from this break is the brightest and cleanest of any, and the most should be made of it. It is fair to say that the first and second breaks are preparatory to the third and fourth; but, as far as that goes, each break should be preparatory to the next, and the sixth, or last, to the feed pile. It is well to consider what follows in setting the breaks, and there is this fortunate circumstance, that when one is thus looking ahead, he is doing the best possible thing for the work immediately in hand. For example, when one is setting the second break rolls, he has in mind the quality of stock desirable for the third and subsequent breaks, and, in so doing, the product of the second break is benefited by this intelligent foresight.

Mention has been made that with soft wheat closer grinding is required on the first and second breaks, than with hard. This is for the purpose of getting the work of reduction sufficiently advanced so that the grinding on the third and fourth breaks may be more open. Close grinding on these middle breaks with soft wheat means soft flour and flat, soft middlings, which are difficult to purify, and, at the same time, the bran is left in such a condition that it leads to unnecessarily impure stock on the fifth and sixth breaks, and bran which it is difficult to clean. If one were to grind as close on the first and second breaks with hard

wheat as he does with soft, the stock would be too much cut up when it reached the fourth break. Such a condition of things would suggest a more uniform grinding with this class of wheat. A good general rule in regard to the breaks would be to so grind as to keep the stock in as large pieces as possible for the next break. This idea, well followed up, would work out its own methods, and, approximately, those just enumerated.

The corrugations for the third break are usually cut fourteen to the inch; sometimes twelve, but not commonly so. The question of round or sharp corrugations is one which will settle itself if it is ever settled. The difference in merit as to the different corrugations is not so great but that all are being operated successfully—that is, they are making money—and every miller appears to be satisfied with the roll which he is handling. If asked squarely which form of corrugation was the best, the writer would say the one which makes the largest proportion of middlings and leaves them in a condition to be most readily purified, and at the same time yields the best quality of break flour. If asked which corrugation would meet this idea, the writer would say he did not know, as there are very many different forms made and operated under many different circumstances, and a positive opinion on such a basis would not be entitled to respect. This is a question which will settle itself when there is any need for its being settled.

The speed of corrugated rolls is a good deal talked about, and might as well be mentioned in connection with the third break, as any place. It would sound very well to say that rolls should run slower operating on hard wheat than on soft wheat. At first glance this might appear to be true and to be sustained by results, but the fact is that the evils of running rolls too fast are not so apparent on soft wheat as on hard. But they exist just the same, and if a high speed is wrong on hard wheat, it is wrong on soft. It is supposed that we are working to get the best results; that is, to get the most money out of the wheat. Where the result of a wrong is distinctly apparent, the fact of its being less apparent under other circumstances does not imply that a wrong does not exist. This view of the case is brought to mind by a spring wheat miller, who said, while we were looking at a set of rolls which were running very fast: "If those rolls were running on spring wheat, they would knock the wheat all to pieces, bran and all," and then as he talked about it he suggested that the evil was only one of degree when applied to the soft

wheat on which they were running. The general impression is that 225 to 250 revolutions per minute is about right.

The question of differential motion on breaks would be as endless as the former discussion as to the speed and dress of millstones, and will not be entered into at this time.

The scalping reel following the third break for a 400 or 500-barrel mill should be twelve feet long, and for from 100 to 200 barrels, about six feet long. A fourteen corrugation on third break stock would require No. 22 wire as the proper clothing for this reel.

The fourth break stands up well with the third. It is rather specky, is softer, the granules are smaller, and the volume of stock somewhat less. More harm can be done by poor grinding on the fourth, fifth and sixth breaks than on the first, second and third. It is because the proportion of deleterious material is larger as the tail end of the breaks is reached, and then again, the bran which has been subjected to the severity of the previous reduction machinery, begins to break up and pulverize. The legitimate end in milling is to make good flour and clean feed. These two things have to be kept in mind at every step, counting from the first break down. In order to make clean flour on the fourth and fifth breaks, one wants to touch pretty light on the stock, and, on the other hand, we want clean feed. Allowing that this is so, it will naturally suggest that we should grind as close as possible so as not to injure the stock as to its quality or size, on the first two breaks. This statement would bring about the old talk about the different ways of grinding hard and soft wheat. Any grinding which implies bruising or mashing is improper or wrong. It means pulverized bran, flaky middlings, and soft flour. All this is dependent upon the extent to which the evil is followed. It is a question of degree. This matter of degree is the sum and substance of milling results; it is the degree of purity or impurity in flour. There can be no absolutely pure or impure stock in the mill. The word clean, as applied to flour and feed, is in the same position. They have to be used in a licensed and unsatisfactory way.

The fourth break rolls, as a matter of fact, require more grinding surface than any of the other breaks, but usually have the same amount as the third, which is about as near as one can get to the desired result in actual practice. The reason this extra amount of grinding surface is required is that there are a larger number of pieces than before, without a corresponding reduction in the bulk of the pieces.

The corrugation for the fourth break is usually sixteen or eighteen to the inch—sixteen, probably, more often than eighteen at this time. There appears to be a growing favor for coarse corrugations on winter wheat, however it may be for spring wheat.

The scalping reel for the fourth break should be clothed with No. 24 wire or its equivalent in grits gauze. Grits gauze, by the way, lasts very well on the fourth break. The other breaks will cut it out too rapidly to justify the expense. The length of the scalping reel for this break on a 400 or 500-barrel mill would be thirteen or fourteen feet.

It is a common thing in many mills not to open the first three breaks when shutting down the mill, but merely to cut down the feed.

From the fourth break scalper there is the natural drop to the fifth break, and it is a drop in the sense of a descent from one elevation to another, and also from a higher quality to a lower. At the best this fifth break stock is questionable in quality, and more particularly as to the quality of the middlings. Where one is running the four middle breaks together—the second, third, fourth and fifth—if he will take the fifth break out, he will notice a wonderful difference in the quality of the middlings. It will show with all the middlings which pass through a No. 4 cloth, or finer. Whereas, it might have contained fine, fibrous, red stock in case of the fifth break middlings being run in, it will show much cleaner with them left out. There is quite a quantity of coarser stock which goes in with the coarse middlings with this break, but there cannot be any considerable quantity of coarse middlings; in fact, the quantity must necessarily be very small, owing to the thickness of the stock before it is reduced, and its generally depleted condition. However, there is quite an amount of stock which will go through coarse cloth. It is bran with a small amount of adhering middlings. Altogether this substance is more like tailings, and should be treated as such. It is not an easy matter to get the fifth break fine middlings in a condition which will justify its reduction into patent flour. But they will make a most excellent quality of clear or bakers', if reduced on smooth rolls. Whatever may be said about the middlings from this break, the flour belongs, beyond question, with the clear; that is, the flour made during this reduction. It is relatively of a better quality than the middlings. The quality of the stock going to the fifth break machines—its size, texture and general appearance—is an indication of the care and skill given in grinding on the previous breaks. It is here that previous good or bad work

shows itself the plainest, and it exerts a marked influence on the quality of the product of this reduction. If it comes to these machines in bad order, no work, however skillful, can redeem it.

Twenty corrugations to the inch seems to be the accepted cut for rolls for this break. No. 26 wire or the corresponding size of grits gauze is used for the scalpers. Thirteen or fourteen feet is a good length for a 300 or 400-barrel mill, and, for the reason previous'y stated, about half that length would do for a mill of from 100 to 200 barrels. Comparisons are often made for a 400 or 500-barrel mill similar to the above. This does not imply that this work is done for 500-barrel millers, but rather for the purpose of comparison and proportion. One has to take something for a basis in order to work both ways. There are a great many more mills which are smaller than this than there are of this size and larger. In fact, the writer judges that the number is so much greater, that the aggregate output from them would be immensely larger.

A very successful millbuilder told the writer that all four-break mills should have five breaks. He said that in all mills where they placed a four-break combination machine, they sent the tail of the last scalper to a single pair of rolls to clean the bran. It is customary to speak of all reductions by corrugated rolls as breaks. In a six-break mill the first four reductions are, in practice, breaks; the fifth and sixth, cleaning reductions. They scrape the bran, however. The writer has no disposition to complicate the general expressions or nomenclature of milling operations by inviting a distinction in the naming of these reductions.

There is a general disposition to separate the fifth break stock from the usual stream of material from the middle breaks. While it has been the custom to run the products of the second, third, fourth and fifth breaks together, and bolt out the stock as though it were one product, there is a disposition to draw out this fifth break stock and bolt it by itself. The flour is nice and bright, but the middlings do not belong with those from the second, third and fourth reductions. They are red, fibrous, and generally irredeemably bad. Their condition may be improved, but the purification cannot be effected to such an extent as to make a desirable proportion of middlings suitable for patent flour. This may be proved by undertaking to purify these middlings by themselves. To be sure there will be a small proportion which is all right, but there s shown to be such a large amount of bad material that the evil of running this stock into the best flour in the mill cannot but be seen. All

this applies with greater force to winter than it does to spring wheat milling, though it may be considered as applicable in principle to the latter. It may be said that the taking out of this fifth break stock from the body of the mill from the stream of products from the three previous breaks will reduce the proportion of patent flour. Not so; it will reduce the bulk of stock going to the purifiers, and the bulk of purified middlings may be slightly reduced; but the perfection of their cleaning will be more apparent, and when it comes to their reduction into flour, it will be found that as much or more flour will be taken from the reels where the middlings are bright and clean than where they are less bright and clean. If these middlings were absolutely pure—something which never happens—they might be reduced so that their whole bulk would go into flour. As it became apparent that the middlings were less clean, it would be found that the proportion of loss would be much greater than the proportion of stock which went to make these middlings unclean. To illustrate this in another way: Say we have 99 pounds of absolutely pure middlings—middlings which might in theory make 99 pounds of absolutely pure flour—and say that some person would drop one pound of finely pulverized bran into the mass. Now, our reduction and separating machinery is not so perfect that it will take this 99 pounds of stock and separate therefrom the one pound of impurities. We know that a large proportion of stock would have to be taken out in order to get rid of the impure material, and even then we would find traces of impurities running through the reduced material. The presence of impurities suggests the necessity of large waste in order to get rid of these impurities. The nearer we can come to cleaning the bran material previous to the reduction of milling stock, the less is the waste. Thus, by keeping out the fifth break middlings from the body of other middlings, the proportion of waste is less; and, while the bulk of middlings may not be so large where this stock is omitted, it will be cleaner, and for that reason the yield of patent flour from the wheat will be larger.

Merely because the fifth break middlings are not run into the body of other middlings, there is no reason why they should not go onto the purifiers. Enough benefit may be derived from this stock to justify the expenditure in extra spouting and elevators, and, if need be, extra purifiers. The need of extra purifiers is spoken of in this questioning way because it is not always necessary to buy them new. In quite a num-

ber of mills which are large enough to justify this division of stock, it will be found the middlings can be made much cleaner, after taking out the fifth break stock, with one or two less machines, than they could before with full equipment on one general classification of stock. Most of the middlings from the fifth break which one would care to run into a purifier will pass through a No. 4 cloth, and, as the wheat is harder, it will be found that there will be an increasing proportion of these middlings which will be suitable for running in after purification, with the other stock, and for the reason that these middlings are fine, there need be but one grade of these middlings to be purified.

The amount of middlings from the fifth break is usually overestimated. The stream of stock is quite large, but it is mostly made up of fine bran and fibrous matter. One can prove this to his satisfaction by taking some stock from the fifth break and sifting it. The large proportion of fine bran and the small proportion of real middlings will then be made apparent. It would be drawing it a degree too fine to suggest that the fifth break flour be bolted separately. All that is absolutely necessary in the separation of fifth break middlings is to run the product of the fifth break scalper into a separate middlings scalper clothed with, say, a No. 9 cloth. Then the product of this No. 9 cloth should be run into break flour reels.

CHAPTER XXX.

THE FIFTH BREAK—NUMBER OF BREAKS FOR A GRADUAL REDUCTION MILL, SEVEN BREAKS—SMOOTH ROLLS FOR ONE OF THE LAST BREAKS—THE SIXTH BREAK—SIXTH BREAK SCALPER—SIXTH BREAK FLOUR—BREAD FROM SIXTH BREAK FLOUR—SIXTH BREAK FLOUR SHOULD BE RUN BY ITSELF.

According to the original plan, it might be in order to drop the breaks at this point, and take the products of the four middle reductions and dispose of them, but while we are about it, we wi.l go on and finish up what might be said about the sixth.

Six reductions by corrugated rolls is the smallest number possible, where good wo1k all around is desired. Of course there are many reasons why less are used, and it is desirable that study and attention be given to mills with a smaller number of reductions. They are a necessity, and do better work than was done by the old system. As far as quality of flour goes, it is possible to make as good flour on a small mill as on a large one, but when one comes to do this in this way, it has to be done at so large a cost—at such an expense of stock—it is a dead loss. There must be a great deal of good and poor stock together thrown away in order to bring about such a result. Such miliing would not be entitled to business consideration. The mills with three and four reductions, as they are now built, are better than they were some time ago. The rage for large mills having been largely satisfied, those engaged in building mills are giving this question of small mills their attention; but they cannot be made to compete with the more fully equipped organization, and, while such mills are being built, he who plans or arranges them should have in mind the addition of a sufficient number of breaks to make the mill complete. When one considers the difficulties of making clean flour, sharp middlings, and clean bran with six reductions, and more especially on soft wheat, it would seem rather hard to cut this number down to four. Something would have to be sacrificed. It would be the yield—the flour or the middlings—and at certain times it would necessarily have to include them ;ll. There are

few millers who have not wished for a seventh break, which is certainly a move in the right direction. Seven breaks are used in a number of instances. If six breaks are necessary on spring wheat, as they certainly are, seven breaks are equally necessary for winter wheat.

The writer does not wish to have his statements construed into crying down the three and four break mills. They are a commercial necessity in the places where they are built, and, in a place where a stone mill will keep its head above water, they will make money. On the other hand, the owner of such a mill should remember that a larger number of breaks will do still better, and at the same time do not increase the cost of the mill in the proportion a first thought would suggest. The same shafting would probably do for a six-break mill, a couple of elevators and scalpers; and the additional belting and spouting would about tell the story, counting in, of course, a double set of rolls.

Some time since, in considering the finishing of the bran, mention was made of the possibility of doing a good work with smooth rolls, using a smooth roll reduction after the fifth, and following it with the corrugated reduction, which would be a seventh reduction. This smooth roll reduction would be followed by a dismembrator. The general purpose of this method would be to get a whiter flour from this stock than could be done by corrugated rolls. There would be no middlings. The tendency of the pressure of the smooth rolls would be to pulverize the flour stock remaining on the bran, though it would not detach it. The action of a dismembrator or disintegrator, or something of this kind, would dislodge the flour particles and complete the work of the smooth roll reduction. This stock could be scalped by the dismembrator or separately. The flour from such a process would be much whiter and cleaner than by the ordinary sixth reduction method. The bran would not be so well cleaned, but there would be a certain proportion of good material separated which would not otherwise be secured. This idea was suggested by some work of smooth rolls in reducing wheat. Each reduction was followed by a dismembrator, the flour was of excellent quality, and the middlings surprisingly bright and round. This was a system where all the work was done on smooth rolls, excepting, perhaps, the first, which was closely corrugated. It comprised four breaks, and the bran was quite clean; in fact, the finish was as good as from many four-break mills. It is strange that we have not heard more of the results of this plan, as the showing was good, and it appeared to

have considerable push behind it on the start. One thing it did show very clearly, was that it was possible to get much better flour from bran stock than by more severe methods of reduction. It is clear enough on the face of it that smooth rolls will get a better quality, though not so large a quantity, of flour from this kind of stock than sharply corrugated rolls. To make up the matter of quantity we have the dismembrator, and following its action the seventh reduction, or corrugated rolls. These rolls would be dressed and arranged otherwise the same as for the sixth reduction by the ordinary method. Here we have an equipment which, taken altogether, would get more flour of better quality out of the wheat—which means more money—than the ordinary arrangement. The seventh, or last reduction, would find the stock in good condition to clean.

Mills which are arranged on the basis of three, four, or even five reductions, are necessarily temporary as far as that number of reductions is concerned, and this should be kept in mind in planning a mill. The same cause which led to the change from millstones to rolls in the first place, will inevitably and certainly cause us to finish out the line of breaks. After the change from millstones to rolls has apparently been made, taking the whole country together, there is going to be a big business for millfurnishers in finishing up mills; that is, doing over again and adding to, work that was improperly or incompletely done. There are twenty mills incomplete in many respects where there is one which has enough machinery in it for the quantity of work it has to do. The greatest deficiencies are in small mills, where they are short of capacity, head and tail, and all the way through. The corrugated rolls are crowded and there are not enough smooth rolls; the number of reels is limited, and the purifiers are wonderfully overworked, both as to volume and quantity of stock; and, as said before, there is going to be a large business straightening this out. The necessity for this work is as clear and inevitable as was that of the original change.

To take the sixth reduction as it naturally follows the fifth, there comes to mind a time when thirty corrugations to the inch was almost universally used for this break, but it did not take people long to find out that this was too fi e; they would do all right until they began to wear, and then the trouble would begin. After this was noticed, the change to twenty-four corrugations was made, and now that number is almost universal. To get the best work out of bran rolls, the stock should go to

them broad and most thoroughly dusted. It is easier to get broad, finished bran from rolls while they are new than after they have been run for some time. This is because, in the former instance, the rolls do not have to run so close.

Sixth break rolls are usually run somewhat faster than some of the other breaks. This is done to gain capacity, as the necessity of the case demands that this break should have as much, or more, grinding capacity than any other break. This is on account of the spongy character of the stock as it goes to the machine, and the way in which it feeds.

A good scalper for this break is a common form of centrifugal reel, with the reel stationary, and spiders with steel blades running at about 350 revolutions per minute. The spiral should be about one-sixth. These reels are ordinarily made in halves, with the top to come off. As the reel does not revolve, it is not necessary to clothe the extreme top of it, but it should be closed with tin or zinc. The wire is put on from the inside of the reel. It being in halves, it will be readily seen that this is a very simple process. The longitudinal ribs are seven-eighths thick and about eight inches on centre, and those which run around the reel are the same thickness and five inches on centre. A good way to put wire cloth on such a reel is to first cover it with coarse cloth, four meshes to the inch, securing with two-pointed tacks or small staples. This forms a solid groundwork on which to place the finer wire. A reel of this kind seven feet long will take off the bran from a 500-barrel mill and whip it out so clean that there will be no work for a bran duster. For this break this reel should be clothed with No. 30 wire.

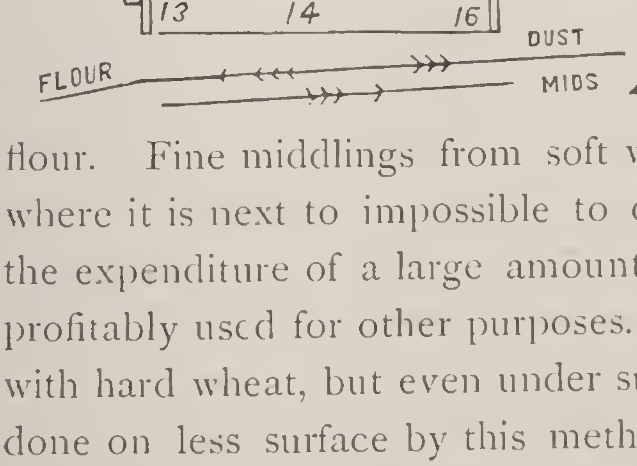
There is another mistake sometimes made which is worthy of consideration, and that is the running of sixth break flour in with the low grade. This flour is far superior to that made from the red dog. It shows better under the spatula, works better in the dough, and is better. It will bring in more money. It makes toothsome, nutritious bread, and any miller who will take the pains to take out a little of this flour and bake it, can easily convince himself that he is doing a wrong thing when he runs this product in with the low grade. The bread will be about the color of light manilla paper, but it comes nearer having a positively attractive taste without the use of butter, than any other. The reason for this bread being so nutritious and pleasant to the taste, may be found in the fact that the larger proportion of gluten sacs or

cells are found next to the bran. The scraping off of this part of the wheat by the sixth reduction rolls, is the explanation of the excellence of this flour. The analyses of the products of C. A. Pillsbury & Co.'s mill by Mr. Richardson, of the United States agricultural department, show the correctness of this theory, in that the sixth reduction chop proves to have the largest proportion of albuminoids or nutritious matter. According to the analyses, there is an increase from the second to the sixth, the second break containing the smallest proportion of albuminoids and the sixth the largest. The first chop contains a larger proportion than the second, on account of the germ which it contains. The first break flour would be found to have a smaller proportion of the albuminoids than the other breaks, though the chop which contains the germ may be shown to have a larger proportion than the second. The writer would not run the sixth break flour in with any other. If sold by itself it makes a good XXX St. Louis grade.

CHAPTER XXXI.

DUST MIDDLINGS—DUST MIDDLINGS FROM HARD AND SOFT WHEAT—PURIFICATION OF DUST MIDDLINGS—THE CUT-OFF FROM THE BREAK FLOUR REELS—RETURNS.

The product of the four middle breaks contains all of the high grade flour there is in the mill, and of course a part of the low grade, which is taken out by the various separating devices; that is, that part of it which is recognized as low grade flour, because of its going into the low grade packer. If one were inclined to be too particular or annoyingly exact, he might say there is always a certain proportion of low grade stock which gets into high grade flour, and certain high grade flour into low grade stock. But this would be carrying out in a detailed way the statement that milling methods are not and cannot be perfect. The first thing usually done with the break chop is to remove the middlings by dusting the flour out of them. Sometimes this is done by first taking out the coarse middlings, and next the finer. But this can be done at one operation, and at the same time they can be graded into two grades. According to the experience of the writer, the dusting can be more effectually done by keeping the coarse middlings in with the fine while they are being dusted, but not after it is desirable to take out



flour. Fine middlings from soft wheat can be well dusted in this way where it is next to impossible to do it in any other way, excepting by the expenditure of a large amount of bolting capacity, which might be profitably used for other purposes. It may not be necessary to do this with hard wheat, but even under such circumstances the dusting can be done on less surface by this method than otherwise. It might be suggested that the coarse middlings would beat the red stock through into the flour stock and fine middlings. It could not have this effect with the fine middlings to any greater extent by this method than by any

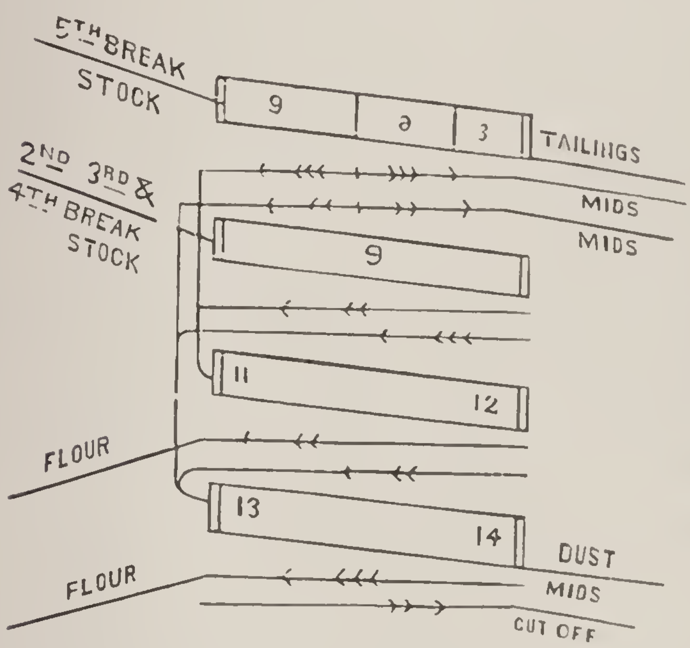
other, and in case of the flour, there is a way out of the difficulty, which would work well in connection with any system of scalping. It is illustrated by the accompanying sketch.

Whenever the miller notices that the flour stock coming from the tail, or near the tail, of the No. 9 cloth, is red, or contains too large a proportion of impurities, he can throw such stock into the bottom conveyor by drawing slides, and from there to the bottom reel, where it will be bolted on finer cloth than it would be if it went into the first flour reel, as will be noticed in the diagram. The cut-off from the first flour reel also goes into the second reel with this stock; thus both meet the requisite cloth numbers to make cleaner flour. The flour from the second reel can be improved by throwing in softer stock from the first.

A method which is not at all uncommon is to take out the coarse middlings through the flouring reels, and finally tail it over the last; if not over a flour cloth on this reel, over a piece of slightly coarser cloth placed on the tail end of it. A still more common way is, after taking out the coarse middlings, to run the fine middlings through the flouring reel and tail off over a fine middlings cloth at the tail, say No. 9. The objections to such a method, which are quite grave, were outlined in a previous chapter when considering, in a detached way, some points in regard to scalping. It is not necessary to go over this here. It is sufficient to say that the idea was to dust the coarse and fine middlings together for the purpose of getting all the flour out of the latter, and at the same time to keep the flour stock as soft as possible by keeping the fine middlings out of it. The purpose of keeping the flour stock soft is to make the flour cleaner. The methods just outlined, and to which objection was made, do neither of the things which are here mentioned as desirable; that is, it keeps the flour stock sharp enough to injure the flour coming therefrom and still not sharp enough to dust the fine middlings. A little examination of the diagram here given will show how these objections are met, even where the plan of throwing the more impure stock, which comes through the No. 9 cloth, into the bottom reel is not resorted to. The tail of the last reel is called dust middlings, and will invite detailed attention.

But before doing this, the idea suggests itself of considering the plan of treating the stock from the fifth break by itself, in the separation of the flour therefrom. This would bring the second, third and fourth together, and, as implied, the fifth by itself. The reasons for doing this, as

formerly named, are that the middlings from this break injure the middlings stock from the three breaks mentioned, and make the process of purification unnecessary, elaborate and complicated. The necessary thing to do in bringing about this result, is to have a separate middlings scalper for the stock from the fifth break. This is illustrated by the diagram here presented. The product of that scalper is shown as going in with the stock to the bottom of the reel; that is, it is arranged so that it may all be sent there, though it is possible that there may be times when it will be desirable to send a part into the upper reel. It should be remembered that the flour from the fifth break is not relatively of so low a grade as are the middlings.



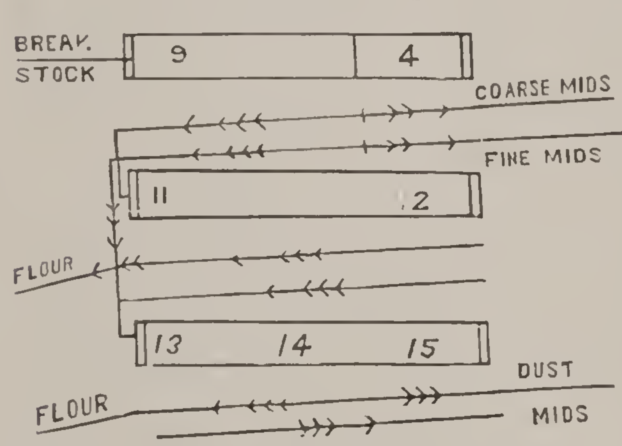
The tail of the fifth break scalper is supplied with a grading and scalping cloth, so that a part of the product of the fifth break stock scalper can be sent directly to the tailings rolls. The grading cloth suggests that the middlings be run into two grades. It would depend upon the size of the mill, as to whether it would be desirable to do this. If not, this grading cloth could be omitted, and the middlings run to a distinct set of purifiers. Where the middlings are divided into two grades, it would imply that one or two extra machines should be used. A part of the purified middlings from this break would be good enough in quality to run in with those used in making the patent flour. The fact that all these middlings are not adjudged good enough for patent flour does not imply that a part may not be used for that purpose, and, furthermore, it does not suggest that the discarded portion should be run in with the tailings, or other stock of similar grade. There is an intermediate grade between purified middlings and tailings, and it is here this stock belongs.

CHAPTER XXXII.

PRODUCT OF THE FOUR MIDDLE BREAKS—SCALPING OF THE MIDDLE BREAK STOCK—GRADING THE MIDDLINGS—CLOTHING OF THE BREAK FLOUR REELS—A METHOD OF SEPARATING THE FIFTH BREAK MIDDLINGS.

The last chapter closed with an allusion to dust middlings. The diagram or illustration which was given in connection therewith is here repeated, in order to define what is meant by dust middlings. The naming of stocks is so mixed and uncertain that explanation at some length is often necessary in order to make oneself understood.

It will be noticed that what is here named dust middlings is that class of stock which will pass through the No. 9 cloth above, but not through the flour cloth below, being too fine to be treated in the regular way with the other middlings, and too coarse for flour. Efforts are made to purify this class of stock in the regular way by the purifiers. According to the present understanding of the case, very little is gained by such means. The stock may be a little purer, but, as an offset, the waste is to be considered in estimating the value of the purification. The difference in specific gravity between the stock and the contained impurities is so slight that as yet we are deficient in the mechanical means of making such a separation by means of air currents or sieves. The writer does not mean to say that the purity of this stock will not be affected by the action of the purifiers in the regular way, but questions the profit of such a process. Mechanically it might work reasonably well; viewed from a business standpoint it will bear investigation. The writer is aware that the dust collectors keep the stock from the fans inside the mill; and also that the tailings and cut-off from the machines handling this stock are controllable in the direction of its travel. But if special means be used in disposing of this stock, or of that from the



dust collectors of the same machines, there is the additional complication and expense of plant, which cannot be undertaken except in a few cases, and that when the output is large and means abundant. And again, accepting all these arrangements as possibilities, the stock to be so handled would not be very much different from the original middlings going to these machines, and the middlings would not be greatly improved. Thus, in any event, the result of such a system could not be largely benefited.

With soft wheat this grade of stock is quite bright, if not contaminated with other material running in with it from other directions than from the stock from which it is supposed to be originally taken. In some instances, where it is desirable to submit this material to purifying action, it is run through a centrifugal reel before such handling; that is, by the purifiers.

The best purifier for the dust middlings is the smooth roll and the following reel or reels. This flour stock is reduced and the bran specks and other impurities are not greatly disturbed. This stock should not be ground too close, as by this means the impurities are pulverized and the floury particles flattened in such a way as to go off with the impurities. There can be no reason for a close grinding in this material. There will be more flour taken from the reel when the grinding is properly done than when it is ground close. What is wanted is to break up the floury particles without submitting anything to a pulverizing action. Aside from the other damage which close grinding does, it makes it difficult to finish up this grade of stock on the subsequent reductions. By that is meant it becomes soft and feathery, and is partially insensible to the action of the following roller reductions. It passes through the rolls without being disturbed, and one reduction merely calls for another, until the tail end of the mill is reached, and even then there is stock going into the red-dog from this source which does not belong there. It is not there through deficiencies in the process, but from lack of the proper manipulation of the means at hand. By the most careful and intelligent grinding this will happen in a less degree. It will become somewhat soft, and, as expressed before, somewhat feathery. The introduction of the centrifugal reel in the separation of the second reduction of this grade of material would not be out of place. If there be a third reduction, as there should be, there should be a centrifugal reel there also. Three reductions of this material where the feed is not too

heavy and the grinding neither too close nor too open, will prepare what remains for the red-dog.

The flour from the first reduction of the dust middlings will be next to the patent flour in quality. When one finds this flour specky and gray, it may be from two causes other than the character of the original stock. It may be from too high or too low grinding. The cut-off or the tail will show which is wrong, without going to the product before it goes into the reel, which it is not always convenient to do from the point where the flour is discharged. It is not always necessary to change slides to remedy defects in the quality of the products of flour or other stock. More often when there is not a change in the feed or the texture of the stock, a change in the reduction will bring about the desired end.

The cut-off from the last break chop reel remains to be considered. There was a time in the history of stone milling, and in fact it was all the time previous to the last few years of the existence of that system, when this or corresponding stock was called returns. To quote an old phrase, "it went back to the head of the chest." The setting aside of this system of returning marked an epoch of decided improvement. It added greatly to the purity of the flour. It was an old habit, one almost as old as milling itself, and it was hard work getting out of it. It was not alone the cut-off from the chop which was sent back as returns, but the cut-off from nearly everything in the mill, as well as dustings from middlings and other questionable material. As a matter of fact, if the miller of those times did not know what else to do with certain stocks, he spouted them into the chop elevator and his mind rested easy. If the same system had been carried on in the purification of his own blood or its manufacture, he would have been a dead man inside of forty-eight hours. The organizer of the human system of purification did not adopt the system of returns, but his creatures introduce it into their anatomy when they drink water contaminated with their own offal by means of cesspools and sewerage, and in other instances by breathing the air from water closets and sewers. This is taking back into the human system material which has once been discarded; it is a method of returns, and it kills through the medium of typhoid fever and other diseases. This system could not make itself so prominently felt in the manufacture of flour as it could upon the health of human beings, but when considered with reference to its relation to good milling, to the purity of the stock, it was pernicious in the extreme. It was undoing what was the avowed

purpose of milling methods to do. It was taking out poor stock and then putting it back again. It was an attempt at purification. It removed a part of the impurities from one body of material and dumped it into the same stock which followed. This system is still in existence in a mild way in the diagrams which are published from time to time, but it exists only in the lower grades of stocks, and does not affect the flour which is taken out earlier in the process.

This cut-off is stock which comes for the most part through a No. 14 cloth. It is flour which is too gray or impure to go into the packers. It is larger grained than some of the flour which goes through a coarser cloth above. This is because of the stocks toward the tail end of this reel being sharp, and containing only a small proportion of fine flour. Thus it drives its way through the cloth. In many instances it is common to run this material in with the dust middlings, and thus reduce it there. The objections to this method are, in the first place, that it makes this stock soft and difficult to feed on the rolls, which is a very serious matter. In the second place, though not second in importance, it is reducing stock which has already been through a flour cloth. This is unnecessary and need not be done. It accomplishes nothing. This stock may be spouted in with the reduced stock from the dust middlings rolls, and thus go into the reels following to be rebolted. Where there are more than two reductions of this stock it would be better to send it in with the reduced material from the second reduction of the dust middlings. No one who has not tried this method of separating this stock from the dust middlings before it goes to the rolls, can appreciate the difference which it makes in the feeding of those machines. It transforms the process of tending such rolls from an annoying, vexatious one to a comparatively simple and easy work. There is no choking off of the feed, consequently the rolls never "run dry" on this account. When the soft stock is running into the hopper there is great temptation to raise the feed gate high, and let the stock all run into one end of the feed opening, and consequently through only a part of the reduction surface of the rolls. Such a condition of things not only does the stock very little good in the way of reduction, but is injurious to the machine itself. The importance of this matter of even, regular feeding on rolls cannot be overestimated. It not only has a decided influence as to the capacity of the machine in reducing the stock, but its influence upon the quality of the flour coming from that roll is wonderfully marked.

Take the stock when it is running through one end of the rolls as described, and then compare the result in flour with that of a roll properly fed, and any one will say that there is a large difference in favor of the latter.

To return again to the question of the cut-off: Its quality and sharpness will be dependent upon the amount of flour taken off, together with the amount of flour in the dust middlings, which is the tail of the last reel. The quality of flour from the last reel should always be examined in conjunction with the cut-off from that reel. To look at it and see that it is satisfactory in color is not enough. One should know that the cut-off does not contain too much flour, and that there is not stock in it which properly belongs with this reel. It is well to take all the flour of proper quality which one can get at every opportunity, and not run stock over into the next reels with reference to the quality of that flour. There are other means of regulating the quality there, which is by the grinding and the amount and kind of flour cloth used. This thing of running clean stock from one reel into another when not necessary, gives the mill just that much more to do than it should. It is a false principle and poor economy. The cut-off from the last reel, when the slides are properly manipulated, is a good place to judge whether or not more or less feed should be put on the mill. If the flour cloth is nearly all used, and the cut-off still soft, it is clear evidence that the mill has too much to do on the kind of stock which is being handled; or, on the other hand, if any considerable part of the reel is cut out, and this cut-off is still sharp, it is equally good evidence that the mill can have more feed. This is a general rule, and should be considered in conjunction with other stocks in the mill, rather than to be regarded literally and without further investigation. It might be that this part of the mill under certain conditions, would indicate that heavier feed could be used, while at the tail end of the mill there would be difficulty in finishing up what it had.

CHAPTER XXXIII.

THE PURIFICATION OF MIDDLINGS—DEVELOPMENT OF MIDDLINGS—DEFINITION OF MIDDLINGS—THE LIMIT IN PURIFICATION—MIDDLINGS PURIFICATION AS A WHEAT CLEANING PROCESS—FINENESS OF MIDDLINGS WITH REFERENCE TO PURIFICATION—SIZING OF MIDDLINGS—SMOOTH ROLLS AS PURIFIERS.

It was said in the first chapter of this book that the history of purification in general, without special reference to the purification of middlings, would be the complete history of milling, and that an account of the methods of purification would commence with the cleaning of the wheat, and include a description of the various reductions and products, together with the separation and classification of the material on its way to the packer or feed bin. A comprehensive definition of milling would also be a definition of purification. Everything in a mill affects or is affected by the purifier. The purifier brought out the system of gradual reduction, which is a system of middlings making. When it was found possible to purify middlings, the thing to do was to make the largest quantity of them; hence the system of gradual reduction. Previous to this the best millstone work was developed by the purifier. It was the origin of all modern improvements in milling. The man who first developed the idea of the purifier was the one who was the father of all of the recent milling ideas. Purification made pure flour possible. To develop this idea more clearly, it may be said that in order to have pure flour, there must be a pure something to commence with. As wheat could not be purified in its original form, other means had to be adopted, which developed the breaking of wheat for the purpose of purification. This is the only form in which wheat can be purified. Really, this is what the system of gradual reduction means—it is the breaking of wheat for purification—therefore it will be seen that the only form in which wheat can be purified is when it is in the form of middlings, and pure middlings means pure flour. Purification is now the sum and substance of modern milling. Reduction is a detail, and, in so far as a system of reduction aids in the purification of the middlings, it is a good system.

Anything connected with the reductions which betters the quality or quantity of the stock to be purified is so much in favor of that system of reduction. The benefits from a good reduction system will never be realized unless proportionately good purifying facilities are at hand.

The term middlings has no special significance in the present system of milling, but in the old system, where only one reel was used, the middlings was the middle product between the flour cloth and the ship stuff or shorts cloth; that is, it was the middle product. Thus it is probably fair to say that its middle position gave it the name of middlings.

Middlings have been spoken of as broken pieces of wheat, and it has been mentioned that the purpose of so breaking the wheat has been with the idea of more perfectly, more completely cleaning it. To make the expression more forceful, it might be said that the purpose of milling was the cleaning and reducing the wheat. The first thing to be done in that line is by the ordinary wheat-cleaning machines, and then follows the breaking of it into particles with the view of separating the naturally deleterious portions, which impair the bread-making qualities of the wheat in a reduced condition.

Having reached the limit in the cleaning or purification of the middlings, their direct reduction into flour follows. This limitation is brought about in various mills by the amount of machinery contained therein. It is possible for some mills to go farther in the purification or cleaning of the wheat than it is for others, on account of one possessing a larger amount of machinery and a better system of arrangement. Another general limitation, and one that applies to all mills alike, is in the knowledge and general state of the art of milling; that is. there is a limit to the purification of middlings—a limit fixed by the present state of milling knowledge.

As milling is a general wheat-cleaning and reduction process, it must be clear that the distinction between wheat cleaning and middlings purification is merely a distinction for the sake of classification, and not one in fact, the general purpose being the same, whether the wheat be on the cleaning machine or on the purifier. The distinction by nomenclature can be no broader, founded on no other reason than the purpose of classification or convenient distinction.

As has been said before, the cleaning of wheat or the cleaning of middlings renders it in a measure possible to separate the impurities from the stock before its final reduction into flour and before the stock gets

into the flour reels. In this statement may be found a broad distinction between new and old process milling. According to the old process, after the wheat had passed through the primary cleaning machines, it was reduced suddenly and sent into the flour reel in a mass—bran, flour, middlings, impurities and all alike—and while in this condition certain stock was taken through flour numbers of the cloth, for which reason it was barreled and sold as flour, the material out of which to make bread. Any of the impurities which were kept out of the flour had to pass the whole length of the bolting apparatus to get out. The impurities, instead of being the first particles to be removed, were the last, and, as a necessity, certain portions of this material went in with the higher grade of flour. A system of milling to which allusion has been before made, which separated the impurities from the other stock after it had passed through with all the other good material, could hardly be one which would survive. It was supplanted by the later methods—the general purification system—which seeks to separate the impurities from the flour while it is yet middlings. It would be entirely successful but for one fact. It is not entirely possible to reduce all of the wheat into middlings without incidentally making flour.

If it were possible to make all middlings, it would be possible to take away a large proportion of the impurities of the wheat before any of the stock was reduced to flour. It is the measure of the success of the operation of middlings making which fixes the measure of excellence of the later processes of milling above the older; it is because the wheat may be purified to a certain extent before the stock is sent into the reels for the purpose of making the flour separations. It is common in some of the mills to begin taking flour from stock which contains coarse middlings; that is, stock which contains flour and middlings—flour which has been made during the course of middlings reductions.

As a means of carrying out the idea of the system of separations which has been brought about during the years of middlings milling, it would be well to apply, in so far as possible, the system of removing as large a proportion of the impurities as is possible from the flour stock—stock which is too fine for partial purification by the ordinary methods, before sending it to the flour numbers or before making flour separations. This process has been illustrated by remarks in regard to the reduction of the proportion of soft material during the process of making flour separations. This is as far as the system can be carried out

in the bolting of the finer grades of stock—stock too fine or too small as to the size of the granules to admit of its being handled by sieves and suction machines. The finest middlings which it is usual to handle by such machines is the grade which will tail over a No. 9 cloth.

It is fair to say that with this grade, and grades as coarse as will pass through a No. 5 and 6 cloth, that purification is more largely owing to the sieve action of the purifiers than to the suction action, the distinction between the specific gravity of the impurities of this lighter grade of middlings being so small that it is hardly possible to so nicely adjust the air currents as to make the separation on these grades of stock. However, the sieve action is such as to recognize the nicer and finer differences. The lighter particles of stock will be brought to the top by the vibratory motion, or the oscillatory motion of the sieve, and in this way, if the machine is properly cared for, the impurities will float toward or over the tail. With sieves that handle this grade of stock, it would be well that they do not have so severe and quick a motion. While it is highly important that the sieves of all the purifiers should be entirely and evenly covered from head to tail, or to that portion of the tail c'oth where it is no longer desirable to take off clean middlings, it is positively fatal to the successful operation of the machine which handles the grade of middlings previously alluded to, not to have its sieve so covered. This grade of middlings receives less benefit from the action of the purifiers than does any other coarser grade. It is fair to say that the grade of middlings which will tail over a No. 4 cloth and pass through a No. 2 makes the greatest showing of benefit from the action of the purifiers. The coarser middlings are as largely benefited, though they do not show it so plainly. The larger the middlings the more readily are they benefited by the action of the air currents. The larger the middlings the greater the difference between their specific gravity and that of the impurities; hence the ease of the separation by the air currents. There comes a point where the broken particles of wheat are too large to be handled advantageously by the purifiers and other machinery in use in most mills.

The sizing of middlings, which operation may be applied to middlings coarser than those which will pass through a No. 6 cloth, is the most successful method which may be adopted for their purification, not only from the fact that it will release the attached impurities and flatten the germ, but because it will make other positive separations.

In support of the idea that middlings which will pass through a No. 5 or 6 cloth cannot be appreciably benefited by the suction action of the purifiers, it is called to mind that middlings of this grade are seldom or never purified when they are the product of sizing rolls or other middlings reduction machinery. The most successful method of purification for this grade of stock is the smooth rolls and the accompanying reels.

CHAPTER XXXIV.

GENERALITIES IN REGARD TO THE MIDDLINGS IDEA—REMOVAL OF IMPURITIES—DIFFERENT KINDS OF IMPURITIES—MEANS ADOPTED FOR THE PURPOSE OF THE REMOVAL OF IMPURITIES—THE SIZE OF MIDDLINGS, OR PURIFICATION—DIFFERENT KINDS OF PURIFIERS—SMOOTH IRON ROLLS—A GRAVITY SEPARATOR.

Having introduced this subject in the last chapter, by such general comment as the importance of the subject would suggest, the features which apply to the direct purification of middlings will now be taken up.

There are certain parts of the wheat which are deleterious to its bread-making qualities when reduced to flour. The purification of middlings has in mind the removal of such portions. This is a broad statement of what is to be done in the purification of middlings. Such impurities cannot be removed without breaking the wheat up into small bits—that is, middlings—and then removing the impurities. Some of these impurities, and the most notable, are the vegetable hairs; the germ, its coatings and surroundings; the bran, and the interior cellular coatings. This statement will convey as good an idea of the impurities and aid as much in the description of their removal, as if it gave the exact technical composition.

As the purification means the removal of these impurities, the basis of separations must be considered. There must be a difference somewhere in order that there may be a separation. If it were possible for the impurities to be of approximately the same character as the desirable portion of the wheat, the purification could not be accomplished. But there is always a difference in the physical composition where there is a difference in the chemical or other qualities, and where the difference is sufficiently great the separation can be made by mechanical means. The purification of middlings has to be done on a commercial basis, and it will be so considered.

According to present methods the basis of separations is size, specific gravity and general structure. For example, the impurities may be lighter than the middlings, as in the case of the woolly fibre, or they may

be larger, as with bran, or the structure may be entirely different, which makes it so easy to separate the germ. The above illustration, being merely descriptive, does not pretend to enumerate the different impurities coming under the distinctive qualities named.

The differences of size, weight and structure are those which make the purification of middlings possible. They suggest the construction of all purifying devices.

Knowing these qualities, we are now to consider the agencies of purification; that is, the machinery of purification. The separation as to size is accomplished by means of bolting cloth; as to specific gravity by air currents, which allow the heavier particles to pursue one course and compel the lighter to take another; as to the structure, by means of reduction machinery, which reduces the middlings and allows the impurities to remain intact. For example, as to the latter, the smooth rolls may be mentioned, which make a germ separation possible. These agencies being mechanical, there are differences which are not recognized by the various devices. There are impurities in the smaller portions of broken wheat which are of less specific gravity than the desirable portion, and, because of the difference being so small, their purification is not possible on a commercial basis. This is what makes the purification of flour impossible, as it is also a good reason for the production of larger particles, i. e., middlings. In many of the best mills, only such middlings as will tail over a No. 8 or 9 cloth are treated on what are generally known as purifiers. This involves the dusting of the middlings—that is, taking out all that portion which will go through a No. 8 or 9 cloth—and the scalper or dusting reel can be considered as an auxiliary purifying device when the term purification is applied only to middlings.

It is not the writer's purpose to go into a description of machines with which every one is familiar, but merely to record such ideas as he may have on the general principles of their operation. The separation as to size and specific gravity is ordinarily made, as every miller knows, on a vibrating sieve machine—with a current of air up through the sieve—the lighter impurities going in the direction of the air current and the larger impurities toward, or perhaps over, the tail of the sieve, while the pure middlings go through the cloth. This is the most common form of purifier. Another has the sieve to separate the larger impurities as before, while the middlings and a portion of the lighter impurities of corresponding

size go through the cloth in size varying as do the meshes, and thence by gravity through an arrangement of slats or surfaces arranged to deflect the middlings to various positions so as to be exposed to currents of air which allow the middlings to pursue their general downward course and draw the lighter impurities in the direction of the current; that is, horizontally for the most part, and at right angles to the course of the pure product. The Hagenmacher, the Wörner, the Seck and Gray purifiers are notably samples of such machines. The centrifugal purifier has a revolving disc on which the middlings are fed and under which there is a current of air drawing inward. The centrifugal force of the revolving disc throws the heavier particles to a greater distance than the smaller ones, and into receptacles prepared therefor. The lighter portion has a tendency to fall nearer the disc and the light impurities are drawn under and entirely away from the body of purified middlings.

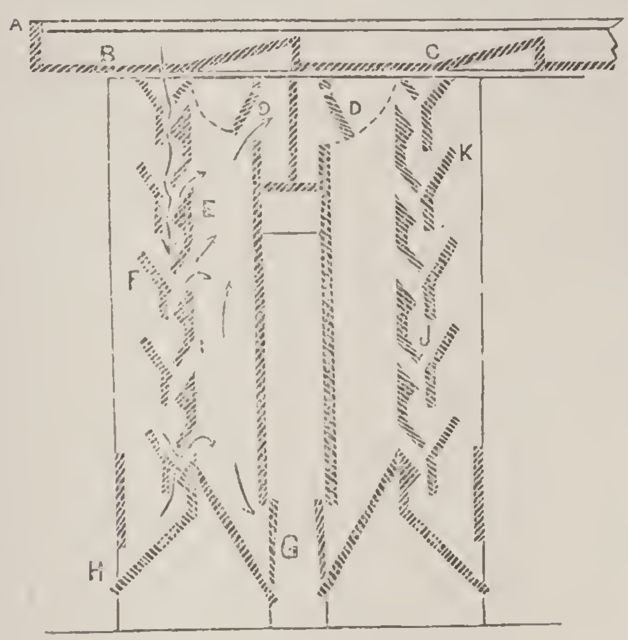
The above mentioned machines are what are ordinarily described as purifiers. In the category the writer wishes to include the smooth iron rolls, which aid in making a separation by reducing the clean stock and allowing the impurities to remain large or their original size, so that they will pass over the tail of a cloth, while the former passes through it. There is no way to separate the sizing rolls from the purification system, and the diagrams and descriptions which are to follow will include them in the exhibits made. As will be seen, the product of the middlings from the mill cannot be purified in any degree of completeness and economy without the use of the smooth iron rolls. There are certain grades of large middlings which can only be purified up to a certain point considerably removed from the proper degree of purity without their use. They are not only for the purpose of changing the relative size of the clean stock and the portion to be removed, but also to change the relative specific gravity of the different parts, at the same time reducing the stock and liberating the impurities. Smooth iron rolls, in combination with separating devices, are as much entitled to the name of purifiers as sieve and suction machines.

The cuts which are given do not pretend to represent the fullness of the ideas expressed, but are illustrative of the general principles of a system which will be shown more in detail another time. The mechanism of the ordinary sieve and purifier is well understood by all millers, therefore a description, general or otherwise, would be wasted.

The cross section shows a gravity separator or aspirator, which may

need a little explanation. It is a form of purifier which is largely used in Hungarian milling. Not this particular one, but of the kind and general principle which is described in this chapter.

The purifier here illustrated is a suction machine. The direction of the suction is between the slats *E* and *F*, and toward the opening *B*, the size of which opening and the force of the suction are regulated by the valve *E*. The middlings pass between the slats *E* and *F* in a downward direction and are deflected from side to side, their progress being arrested by these. The suction draws the particles of less specific gravity



than the good middlings through the openings *J* and over the slat *E* into the chamber at the back thereof. The air, after it passes through the narrow openings, expands to a certain extent and allows the larger portion of the impurities to settle and discharge through the opening *G*, which has a slat covering it in a manner similar to that of the discharge of a separator shoe. The pure middlings discharge through the opening *H*. For this kind of a purifier it is important that the middlings passing down each leg or compartment should be of the same size; that is, they should be graded very close. There should not be a difference of more than one number from one compartment to the next, or from one size to the next. By this means the suction can be adjusted according to the specific gravity of the middlings, and thus make a nicer distinction between the specific gravity of the good middlings and the impurities. If the grading is done on grits gauze numbers, the sizing can be done much closer than by a bolting cloth, as the grading is much closer. There are several sizes of grits gauze numbers to one of bolting cloth. For example, No. 0 of bolting cloth is represented by No. 36 of grit gauze, and No. 00 by No. 28, between which there are the intermediate numbers 34, 32 and 30. When the numbers are finer than 000, there are no intermediate numbers. With such machines there is the grading sieve above, which in the cut is represented by *A B*, which is arranged to grade the middlings into the different sizes mentioned, the cloth being nearer the top, and the discharge openings as represented

by *C*, which allow the middlings to fall through to the slats, to be acted upon as described. The middlings which fall through the cloth in front of the opening *C* are conveyed to that opening on the flat bottomed piece *B*, by the sieve action. These purifiers are generally constructed with four legs to each machine, which requires that this sieve be arranged to grade into as many different sizes.

The purifier just described is regarded by the writer as the best possible one for middlings which are coarse enough to tail over a No. 2 or 3 cloth. They are more effective as to their operation and make a cleaner, closer, more decided separation, with less waste and fewer operations than any other machine. They require less attention, and are therefore more economical as to operation. They are also cheaper as to first cost.

CHAPTER XXXV.

THE GRADING OF MIDDLINGS—A SIEVE GRADER DESCRIBED—AN ASPIRATOR UNDER THE GRADER—THE NUMBER OF GRADES OF MIDDLINGS—THE GRADER AS AFFECTING THE NUMBERS OF CLOTHS ON PURIFIERS.

The grading of middlings, previous to purification, is worthy of serious consideration. In past years this grading has, for the most part, been done on reels. On the system which will be here described, and the diagram given, the grading will be done on sieves or shakers. By this means the middlings are graded without making dust -- at least, there is less dust than by the other methods, and then there is the purifying effect of the sieve action. The value of this sieve action is largely underestimated. Its action is more potent than it is credited with being. It has more to do with the purification of middlings than do the currents of air, as provided for on the ordinary form of purifiers independent of such action. By the swinging hand-sieve motion, the impurities are left on the top, and the heavier middlings are next the cloth. This motion has the effect, in a modern degree, of constantly lifting and tossing the stock on the sieve. The middlings being heavier, they fall next to the cloth, while the light impurities are above, and thus are finally passed over the tail of the sieve. All this presents another good feature of sieve graders.

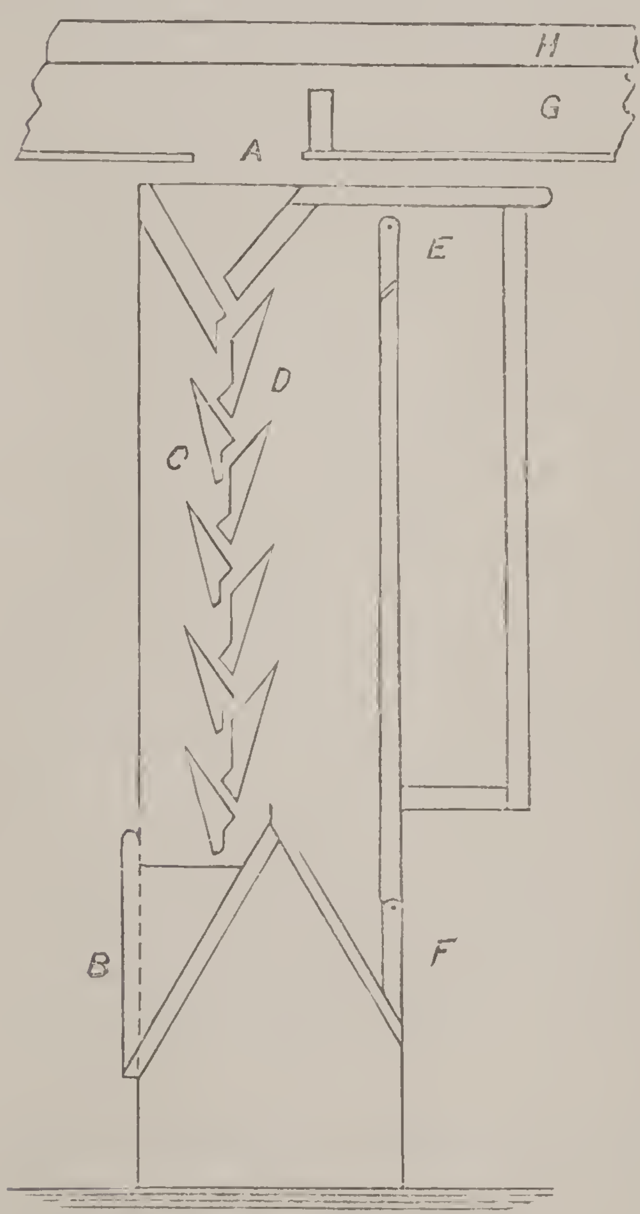
The best grader known is one long sieve or more. It does not make as much flour as a reel grader, and at the same time it has a purifying action, because of the sieve motion. A sieve forty inches wide and twenty feet long will do all the work of grading for a 250-barrel mill. Such a grader is a very simple affair, and very easily made. It should have an inch throw on the eccentric, which should be speeded at about 350 revolutions per minute. The frame of the sieve proper should be supported on hickory springs, which should be about three feet long.

As to the grading of the middlings on this machine, assuming, according to the diagrams given, that they have been dusted over a No. 9

cloth, and the whole body, coarse and fine, has been run to this machine, the following clothing suggests itself:

4 3 2 0 00

This does not necessarily mean that there will be this number of grades of middlings to be purified, but they are divided in this way in order to derive the benefit from aspirators, (one of which is used for each grade,) which are set under these graders. One aspirator, or a single leg thereof, is used for each grade of middlings. A very good form thereof is here illustrated. It is somewhat different from those formerly given. The middlings drop from each section of the grader, and of a size as suggested by the numbers of the cloth, into the opening *A*, and through the slats, as shown, in a zigzag direction, and as controlled thereby. The middlings pass out through the opening *B*. The direction of the suction is from *C* to *D*, the volume of which is controlled by the valve *E*. There will be drawn out a large amount of impurities, the heaviest of which will pass through the shoe valve *F*. This stock should be sent to the tailings. Above the aspirator, as indicated, is a part of the sieve. *G* is a rigid bottom made with a light board, and *H* is the grading cloth. After these middlings have passed through the aspirators in the number of grades as indicated, they may be spouted together into a smaller number of grades, and from thence to the purifiers.



The 4 should form a grade by itself, the 3 and 2 another, and the 0 and coarser a third. The first two grades it would be well to purify on the ordinary sieve and suction machine, and the coarser middlings on an aspirating purifier, of the pattern similar to the Gray, Wörner, or other machines of that class. This is the least number of grades which the writer would suggest for a mill which intends to compete with the ordi-

nary run of merchant mills. There will be still another grade of middlings from the sizings.

As to the number of purifiers required, two for each grade is the least number which may be be suggested for mills of the class named.

The practice of putting many different sizes of middlings on such a machine is fatal to its successful operation. There are more machines running which are clothed with No. 9 or other fine numbers at the head, and No. 2, 1 or 0 at the tail, with intermediate numbers between, than there are with better clothing. As the separation as to specific gravity is dependent upon the difference between the specific gravity of the middlings and the impurities, and as each size of middlings has an accompanying quantity of impurities of the same size, there will be as many grades of impurities, and as widely varying in specific gravity, as there are different sizes of middlings on the sieve. Therefore, where the range is as wide as mentioned, the currents of air cannot be adjusted to meet the specific gravity of the various impurities and at the same time allow the middlings to take their desired course. For example, the specific gravity of the impurities of the coarser middlings may be as great as that of the finer middlings regardless of the impurities. Thus, a current of air which was adjusted to take out the lighter impurities from the coarser middlings, would take with it the fine middlings themselves, thus resulting in waste. It will be seen that it is important that only middlings of approximately the same specific gravity should go to a machine. There should be different machines for the different grades. This will suggest that the machines should be small and numerous. With the gravity separator, where the middlings are not subjected to the action of the air until they have passed through the sieve, the number of different sizes is not so important with reference to the sieve, but very important as to the uniformity of size of the particles fed into each leg. It is one decided advantage for this form of purifier that it grades the middlings with exactness before they are submitted to the action of the air, and as the difference in specific gravity is greater between middlings and impurities of the same size than it is with the varying grades of middlings and impurities before mentioned, the separation is sure to be more exact than it is possible to have it by other means.

CHAPTER XXXVI.

HUNGARIAN METHODS OF PURIFICATION—THE METHODS IN A HUNGARIAN MILL—HUNGARIAN METHODS NOT APPLICABLE TO AN AUTOMATIC SYSTEM.

This chapter on purification is an interruption in the scheme originally laid out. In our present milling methods we have respect for and desire knowledge in regard to Hungarian milling, and whenever we meet any one who knows anything about such milling we are anxious to talk to him and find out what we can with reference to their methods; but it is not common to meet with such persons, and especially with those who have anything more than a hearsay knowledge in that direction. Hungarian milling can no more be learned by walking through Hungarian mills and talking with Hungarian millers and engineers, than can American milling by those outside by the same means. Bringing home a valise full of samples and a memorandum book full of isolated facts and figures does not represent the fullness of Hungarian milling. If one were to describe a Hungarian mill, he might describe something different from what some of the readers may have seen or experienced in that way, and it might be they would say his description was not accurate. On the same principle, three American gentlemen might meet on the Sandwich Islands, or at home, for that matter, and discuss American methods, and no two of them would be able to agree exactly as to details; but this condition of things would not disturb the fact of their intimate knowledge of the subject under discussion. The details of W. C. & Co.'s mill may be different from that of P. & Co.'s, yet both may be doing good work.

The writer's knowledge of Hungarian milling is limited, but having taken notes of conversations with gentlemen who are abundantly supplied with such knowledge, which has been gained in the active discharge of their duties in operating Hungarian mills, if he should make such mistakes in what he may have to say on the subject of purification as to bring out criticism and comment from those better informed, he would regard the result as beneficial to the milling fraternity as well as himself.

In one of the mills in question there were six reductions of the wheat on rolls, and two or three reductions of the bran on millstones. The reductions on the rolls were much more gradual in this instance than in American mills. Thus the product of the various reductions cannot be spoken of as compared with those of the same reductions with us. In this mill the middlings from the second and third reductions were purified together and the fourth and fifth by themselves. The wheat or stock having passed through the rolls and thence through a scalper, the tail goes to the next reduction, and the product of that reel into the flour reel clothed with Nos. 13, 14, 15 and 16 cloth, the tail of which reel is the dusted middlings, which middlings pass into a reel clothed for grading them. The clothing of this reel is represented by the figures below:

68 60 56 52 46 40 36 30 24 22

The product of each division of this reel—each division being by a number—composes a separate grade of middlings. Thus it will be seen that from grade to grade very few numbers are skipped, and the relative difference from one size of middlings to the next is very slight, which, as before described, renders it possible to purify the middlings economically—that is, with small loss—making the separations with reference to the specific gravity of the middlings and impurities. Each grade of middlings passing through the numbers mentioned is treated on purifiers especially clothed and regulated as to the volume of air for the class of middlings to be handled. The first two grades, those which pass through Nos. 68 and 60, pass to a grading sieve where they are graded into intermediate numbers, from 70 to 56 inclusive, and each number or size represented thereby to a centrifugal purifier, and from thence as purified middlings. These middlings make Nos. 1 and 2 flour (Hungarian grades) when reduced, the best flour being represented by o. The remaining coarser grades of middlings, commencing with No. 56 and ending with No. 26, are purified each on independent machines, with the grading number, and intermediate numbers of cloth. These machines are of the aspirator pattern, and in the mill which the gentleman had in mind when talking to the writer, they used the Wörner machine, a number of which are in use in this country. The middlings which would pass through a No. 56 cloth would go to a machine clothed with Nos. 60, 58 and 56 cloth, and those through No. 52 to a machine clothed with Nos. 56, 54, 52 and so on for each grade clothing in the same way. Each

leg of each machine makes another division of stock of two additional grades—that is, the purified middlings and another grade partially purified, which are drawn over in the manner described in Chapter XXXV., excepting that the suction was much stronger than was contemplated with the machine therein described. By a single operation on this machine, with strong suction, there is obtained one grade of purified middlings for each leg, and one partially purified. The purified middlings, beginning with the coarsest, are sized down one grade at a time; after each sizing the flour being taken out, and the middlings passed through a reel clothed Nos. 8, 7 and 6 cloth, the tail of that reel passing to the next reduction. The product of the Nos. 8, 7 and 6 cloth is purified middlings which reduce to 0, or the best flour, excepting perhaps in the case of the grade represented by the No. 6 cloth. The sizing of these middlings, as said before, is from one coarser grade to the next finer, and so on. By each grade is meant the grades as represented by the clothing of the purifiers and not by the grading reel, as previously mentioned. As they size the lower number it goes to the next higher number, or that which produces the next grade finer middlings. Thus all the middlings are reduced to such an extent that they will pass through a No. 8, 7 or 6 cloth, the operation of dusting the flour out of the middlings, and passing them over a reel so clothed being repeated for each sizing. The flour from the reel which dusts these sizings is No. 1 or 0; that is, the best.

The unpurified or second grade of middlings which are drawn over the leg of each aspirator are passed through rolls and touched lightly, each grade by itself, and run into a reel to take flour out, from which they tail over to a grading reel, which is clothed the same as the one described. This sizing is done merely to change the gravity of the middlings previous to the next purification. Having been graded as described they pass for purification to machines of the same kind, and clothed and operated in the same way, as those for the first purification. The purified product from the purification is treated the same as the middlings from the first purification; that is, it is gradually sized, dusted and graded, until it will pass through a No. 8, 7 or 6 cloth. The unpurified product—the part drawn over in the purification of the other grades—is again subjected to the treatment just described, until the remaining stock is not worthy of purification, after which it is worked down on smooth rolls. It should be remembered that in Hungarian milling the

stock suggests the method of manipulation by means of the various milling machines. The stock being handled by hand for the most part, this course is rendered possible and convenient. In an American, or automatic mill, the course of the stock is arbitrarily fixed by the conveyors, elevators and spouts. In a Hungarian mill, where the stock is run into sacks or buckets, its inspection is convenient and the method of treatment is suggested thereby.

The above is the outline method of purification in at least one Hungarian mill which did good work, and it probably resembles many others.

The facilities for inspecting the middlings render it convenient to grade the purified product with reference to quality, which quality, other things being equal, will determine the grade of the flour.

The best grades of purified middlings are reduced on millstones, and very gradually at that. From the first three reductions of the best middlings, the largest proportion of flour taken out is No. 0, or the highest grade. By the various subsequent reductions of this and other grades of middlings, successively lower grades of middlings and flour are made.

The methods described will show that a very large number of operations are necessary in carrying out the scheme of Hungarian milling. It can also be seen that an absurdly large plant would be required to carry out this scheme in an automatic mill. This difficulty is obviated in their milling by the methods of handling the stock by hand, which render it possible to use one machine for various kinds of stock. One purifier may be used to purify any number of grades of middlings, by merely changing the sieve cloths, which are made interchangeable for that purpose. A single pair of rolls may be used for sizing or reducing various kinds of stock, or a pair of buhrs may be used as widely. And as to the reels, it is a simple question of adaptability in clothing, as to for what purpose they may be used widely.

CHAPTER XXXVII.

THE OPERATION OF PURIFIERS—PROPER COVERING OF THE SIEVE—EXACT WORKING CAPACITY OF PURIFIERS—PRINCIPLES WHICH REGULATE THE CLOTHING OF PURIFERS—EFFECT OF AN OVERSUPPLY OF STOCK ON THE SIEVE—EFFECT OF A FEED WHICH IS TOO LIGHT—MEANS OF REGULATING THE CAPACITY OF PURIFIERS—CAUSES WHICH MAY LEAD TO A VARIATION OF THE PROPORTION OF MIDDLINGS MADE—FORM OF MIDDLINGS—MIDDLINGS MADE BY OVERGRINDING—FIFTH REDUCTION MIDDLINGS—METHOD OF PURIFYING FIFTH REDUCTION MIDDLINGS BY THEMSELVES—DISPOSITION OF MIDDLINGS FROM THE VARIOUS BREAKS—CLASSIFICATION OF STOCK—THE RETURNING OF MIDDLINGS.

In its operation, the common form of purifier requires that the middlings should entirely cover the sieve, in a thin, uniform sheet, so that air in passing through can take with it the lighter particles—the impurities. If the sieve is not covered at any one or more places, the air will come through such uncovered places, to the exclusion of others, as the air will come from the direction where the least resistance is offered. This covering of the sieve is important in any case, but more so where the action of the purifier is dependent upon the uniform passage of air through the sieve.

If the sieve becomes bare, the action of the air currents, as far as any benefit to the middlings is concerned, is greatly disturbed, and at the same time the value of the sieve action—which is not to be overestimated—is almost entirely lost. The light impurities which would otherwise pass over the sieve by floating along on top of the middlings, are allowed to pass through the cloth and go to the next machine as a cut-off, rather than over the tail as tailings. While the cut-off is of a lower grade than it should be, the quality of the stock at the head of the machine is correspondingly reduced.

It is well understood that a purifier should have enough to do, and yet not too much. It is vitally necessary that the sieve should be covered. On the other hand, if the machines should have too much to do, the middlings would not be clean, and there would be waste at the tail. This thing can be partially regulated by the proportion of coarse and

fine cloth. The head and tail numbers are easy enough to determine, and the intermediate numbers may be readily supplied. The quantity of each requires judgment and experience and a knowledge of individual cases. Say we want to determine the head and tail numbers for the middlings which come through the Nos. 3 and 2 cloth. In the present instance it would be well to use the numbers at either extreme of those mentioned. This would mean 4 for the head number and 0 for the tail number. The amount of 4 to be used would depend largely upon the amount of middlings to be handled, and of the 0 only a very small portion in any case, because it is only put there to cover the contingency of the machine tailing over, when it has more than an ordinary amount of work to do. Perhaps No 1 cloth would be better in many instances. The fact of the tail of the grader being clothed with 00 may look like a mistake, considering the fact that the coarsest middlings pass through a 000. This may be explained by saying that an aspirator with a heavy suction should be placed so as to take all stock going over the tail of the grader. From here it would go on to the coarse middlings purifiers.

An oversupply of stock in the sieve impedes the action of the suction, in that the air cannot pass through the volume of stock in a way to separate the impurities. At the same time there is stock going over the tail which does not belong there. The extreme of light and heavy feeds may be practically illustrated in a mill more than once in a day. It might be said that in "case of a light feed, raise the feed gates," but if there were no more middlings in the mill, this would do no good. In case of heavy feed, it will not do to lower the feed gate, as this is not getting rid of the accumulation.

In the foregoing, the clothing of a machine was mentioned as one consideration which would affect its capacity, and it was stated that the proportion of coarse or fine cloth could be increased or decreased according as it was intended to increase or decrease the capacity of the machine. Another way of effecting this same result, mention of which was omitted in its proper connection, is by changing the speed and throwing off the sieve. We will say that the machine has too much to do, that the middlings lay thick and heavy on the cloth, and for that reason tail over heavy and rich, and, as a consequence of the sieve being heavily loaded, the suction cannot do its work properly. All this can be changed by increasing the number of vibrations of the sieve. Making it move faster would take a large body of middlings over the sieve

in a thin sheet. If the feed were too light, a change in the motion of the sieve to make it run slower would cover the cloth; but this remedy is not practicable for ready adjustment, as few machines are so arranged that the speed of the sieve may be reduced without correspondingly diminishing the force of the air currents, which is not desirable.

Another, and by far the best way of regulating the capacity of a machine, is by having an eccentric with a double sleeve, so that the throw can be changed at will. This is sometimes called a double eccentric. It does not mean two eccentrics, but rather one eccentric with a double sleeve. If the stock lies too thick on the sieve and the machine appears to have too much to do, the desired change can be made by increasing the throw of the eccentric. This is done by moving the inner sleeve in such a way as to increase the throw as stated. This makes the stock travel faster on the sieve, and consequently in a thinner sheet. Where the machine has not enough to do—where the sieve is not covered—making the throw less will bring about the desired end. A change in the inclination of the hangers changes the speed of the stock on the sieve, but even on machines where this is a mechanical possibility, millers or purifier men are not inclined to do a thing which is so liable to entirely interrupt the regular movement of the stock, and any changes of the hangers are calculated to do this. The principle of their adjustment is that, where the resistance is greatest next the eccentric, the flow of stock will be more rapid, and *vice versa*.

As far as known, there is only one machine made with this double eccentric, and the millers who have used it have gained very little benefit from its being on the machine, as very little attention was paid to this matter of throw. In making some inquiries, the writer was led to believe that this form of eccentric was first used in milling operations on an oat separator. It may be noticed that with one of these machines the matter of throw or speed makes a great difference in its operation. A little change one way or the other makes a marked difference in the result. The matter of a machine having just enough to do, neither too much nor too little, is of the greatest importance. No system of purification can be so perfect in arrangement but that its work can be made inferior by a disregard of this matter. It is difficult to emphasize the importance of this detail sufficiently. This may be said, that no purifier can be under the control of the miller, nor can be made to work up to its possibilities at all times, without means of adjusting the speed or

throw of the shaker, or some other means of adjusting its capacity. There are many causes which may lead to a variation in the proportion of middlings made in milling. This difference may be caused by changes in the feed on the mill, by the variable quality of the wheat, or by the variable qualities of those who run the mill. As the character of the wheat changes and hence the proportion of middlings, the quality and general form thereof also changes. This same result may be brought about through the changes in the running of the mill when the wheat is uniform. The quality of the middlings is estimated, from a milling or mechanical standpoint, by the facility with which they may be purified. The middlings which are most readily purified are those which are free from flour; those which are made from breaking, not mashing the wheat, they being sharp and angular in form rather than flat and compressed. It is desirable that a granule of middlings should not have an excess of length in proportion to its thickness. The nearer the form approximates that of a cube the better, though it would be absurd to expect exactness in this respect. On the other hand, it is absurd to make long, stringy, or thin, flat middlings. Good middlings are made by breaking the wheat, but not by rasping and mashing. Millstone middlings from slow, high grinding are more readily purified than roller middlings. The reason for this is to be accounted for by the question of form. Stone middlings are more nearly square, or rather their dimensions are approximately the same in all directions. They are spoken of by millers as being "nice and round." The tendency of roller middlings is just the other way; that is, to being oblong or long, rather than round, this form being suggested by the direction of the corrugations, which is lengthwise of the roll. In the millstone middlings there is a smaller proportion which has particles of bran adhering to them. A handful of such middlings, as they come from the dusting reel, would look browner and more specky than the same middlings of the roller mill. In the case of the former the particles of bran would almost entirely disappear after being treated by the purifiers. With the roller middlings this is not the case. While they are much brighter in color before going to the purifiers, there is a larger proportion of granules which have adhering particles of bran. There are two reasons for this. One is in the nature of the reduction, and the other in the difference in size and proportion of large middlings. As to the nature of the reduction making the difference, it is apparent that the rolls break a great deal of the wheat in a

way to make the bran adhering middlings mentioned. Again, pieces of the outside of the wheat are often chipped out by the corrugations. As to the size and proportion of large middlings, which are the class that have the bran adhering to them, it is apparent that such proportion is much larger in roller mills than in the old millstone mills; that is, by the former method, there is a much smaller proportion of fine middlings than by the latter, and, at the same time, there are larger middlings made by the former method than by the latter. The presence of these large and branny middlings makes the process of purification a more elaborate and extensive one than formerly. It invites a larger number of operations and demands the elaborate system of sizings and repurifications which is necessary to bring about the proper results. In this way the introduction of the corrugated rolls created a demand for a larger number of smooth rolls. It is by the latter that the middlings of the class referred to may be purified. By a system of gradual reduction the smooth rolls break the middlings from the bran in a way to render the latter separable from the good material. The bran remains approximately intact—that is, without being broken—while the middlings are detached and broken therefrom.

To return again to the question of form. The objectionable qualities are brought about, more often than otherwise, by overgrinding, either by grinding with too heavy a feed or by grinding too close. If there is any difference, the former is the worst. Under such conditions, the middlings are sure to be soft and clammy. Overgrinding at any one reduction carries its bad effect through the mill. For instance, if the grinding capacity on the second break is cramped, the capacity to make good middlings on the third, fourth and fifth breaks, no matter how ample their grinding capacity may be, will be cramped. The same principle applies to smooth roll reductions. A bad second reduction affects every subsequent reduction.

Fifth reduction middlings were mentioned before, but it is pertinent to mention them again in this connection. The idea which was in mind at that time, was that the reduction in bulk of purified middlings consequent upon their being left out or purified by a separate system, would not be so large as might be at first supposed. The fact of their being run in with the unpurified middlings would imply that they would be more difficult to clean, and, consequently, there would be a large bulk of rejected stock which could not be cleaned, and a large amount o

material going into the tailings. Thus the result in purified middlings would not be proportionally as large, when compared with the original bulk of unpurified stock with the fifth reduction middlings in it, as it would be if this latter material were left out. In the latter event—where these middlings are purified by themselves—the middlings from the other breaks would be much cleaner before going to the other machines, and, for this reason, there would be less offal and waste in purifying them, and consequently not so large a difference in bulk between the purified and unpurified stock. The same idea will apply to the flour. The middlings could not be purified so well with the fifth break stock in them, and when it came to reducing the middlings after they had left the machines and separating the stock on the bolts, a much larger amount of material would have to be rejected, than if the middlings were cleaner. Consequently the difference in the amount of flour made will not be greatly changed by running out the stock in question.

In speaking of the purification of middlings, nothing has been said of the special disposition of the middlings from the different breaks. The inference might fairly be drawn that all were thrown together, and, in so far as it would not influence the matter of purification, such a course is desirable on account of the expense and lack of complication. In a mill of ordinary size, or even quite large—say a thousand barrels—divisions according to the various characteristics make the devices of purification so numerous and varied, leave so little work for each division to do, that there is as much danger of poor work from this source as there is by running stocks of approximately uniform character together. As a matter of theory, the amount of stock which a system of purification has to handle does not influence one way or another the number of purifiers in a system required to do the work. For example, there should be the same number of classifications of stock in a small mill that there are in a large one, and as the different kinds of middlings would require distinct handlings—require separate systems of machines—this would complicate matters to such an extent that the system of purification would be by far the largest and most expensive part of the mill, both as to the first cost and the expense of manipulation. Furthermore, such a large number of divisions would run the stock so thin and in such small streams that it would be hardly possible to do good work with machines of even the smallest size.

In speaking of the different qualities of middlings as above, there was

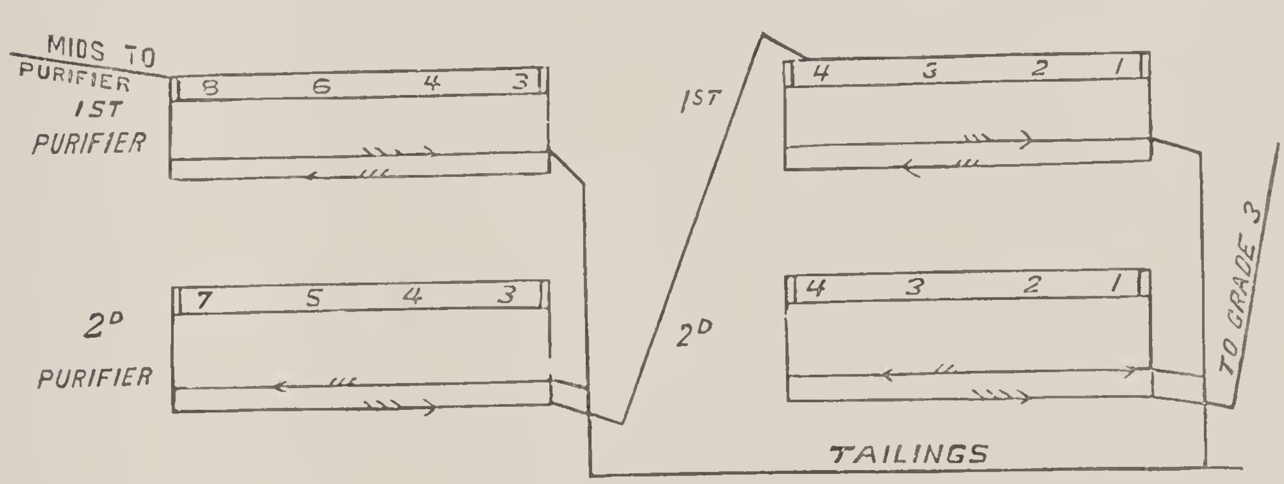
in mind those made by the various breaks. There have been mills built where there was a separate system of purification for each break, but there are very few millers who can think of using such a system; and, for many reasons, of which a few have been mentioned, this will never be a popular method. The middlings which tail over a No. 9 cloth from the first break on winter wheat are bright and in good shape for purification, excepting that they are a little long rather than round or square. Those from the second break are in better condition in this respect, and are easily purified, but the third and fourth breaks, as every one knows, are the best in the mill. The fifth break middlings should not be handled with the middlings from the other breaks. They are small, and should have a system of machines of their own, though it need not be elaborate or complicated, and from this system there cannot be a large proportion of middlings taken which are good enough for patent flour of the best quality.

The system of returning from one reel or purifier back to a reel or purifier from which stock originally came, is one which does not meet with favor in modern milling. It is against the best ideas of separation, but is tolerated in some good mills in connection with the purifiers, and its effect is not regarded as the same as it would be in the case of the softer products of the reels. It is done for the purpose of stocking the machines; that is, giving them enough material to cover the sieve. In the system described this is not necessary, except, perhaps, in the case of the first machine separation. The machines which follow can be stocked by throwing a portion of the cut-off from the second machine of each series to the next series of machines. To accomplish this result with the air purifiers or aspirators, elevators are sometimes used to throw from one series of machines to another, thus taking required portions of clean stock and throwing it to the next machine for the purpose of giving it a sufficient volume of stock to cover the sieve. This may be accomplished in a less satisfactory way by clothing the tail of the second machine of each series finer than the middlings that are intended to pass through it, and elevating them to the first machine of the next series. It is of the utmost importance that the sieves of purifiers, of whatever kind, should always be covered. As said before, the sieve action of the purifier is one of the most important elements of its efficiency, and one which is largely underestimated. The value of the sieve action will never be realized unless the sieve is covered.

CHAPTER XXXVIII.

A METHOD OF ARRANGING PURIFIERS WITH REFERENCE ONE TO ANOTHER —MIDDLINGS FROM DIFFERENT KINDS OF WHEAT—UNIFORM TRAVEL OF STOCK—SIZE OF MACHINES.

In the last chapter something was said with reference to the varying quantity of middlings made in the mill, and that the volume of stock varied from time to time, and to such an extent that the purifiers could not always handle the middlings with equal facility, either on account of the large or small amount of such stock—in one case the feed being too heavy, and in the other too light. It is apparent that there are no ready means of changing the machines to meet these varying conditions, and at the same time it may be recognized as a mechanical possibility to devise means for so doing. The various principles upon which such me-



chanical methods might be based were outlined in the last chapter. There are milling methods in the processes of handling stock which partially accomplish the desired result in the way of a uniform feed. They cannot, however, fully meet the demands of extreme variations in the volume of stock. Such a method is illustrated by the accompanying sketch.

It will be noticed that no finished middlings are taken from the upper machines. This, however, may be optional with the miller, yet the best practice would suggest that it be arranged as here shown. Finished middlings are taken from the second machine, the upper conveyor being used for that purpose. The tail goes to the tailings rolls and the cut-off

to the next series of machines, which handle coarser middlings. In event of the volume of stock on grade No. 1 being too light to do good work, in that it does not cover the sieve, the cut-off may be increased to any extent, and thus the desired portion of imperfect stock is sent to the machine which handles middlings of grade No. 2, which is a grade coarser than No. 1. In the same way and for the same reason grade No. 2 may be cut off and sent to grade No. 3, but there are objections in carrying this thing too far, which objections are to be found in the fact that the value of the proper grading of the middlings is lost by sending middlings of a finer grade with those of a coarser grade to be purified. For instance, those of grade No. 1 are finer than those of grade No. 2, and, while this objection may not be serious when only coarser middlings of No. 1 are sent to No. 2, still it is plainly to be seen that this thing may be carried too far.

As to the quantity of middlings: There is another condition which might have been considered, and that is the varying qualities of the various grades. For instance, in grinding soft wheat, the proportion of large middlings is excessive, and of fine middlings the proportion is small. This is often noticed in grinding soft Fultz wheat in the winter wheat region. Hard Mediterranean wheat yields generally a larger proportion of middlings and of more uniform size than any other. In the case of the former—the Fultz wheat—over half the middlings in the mill will tail over a No. 0 cloth, but with the hard wheat this proportion is considerably reduced. There is a smaller proportion of middlings with adhering portions of bran. The proportion of long middlings is also much smaller; the broken hard wheat more nearly approaches prismatic forms and is more easily purified. Middlings can be broken down much faster on hard wheat than on soft; that is, they can be reduced more at a single reduction, and without flattening or showing flaky. If the rolls were set as closely in sizing soft wheat middlings as those of hard, the reduced stock would be flattened to such an extent as to render its proper purification out of the question.

To return to the question of the variation of the proportion of middlings of the various grades, it is clear that the proportion of the machines and their clothing may be such that one set of machines may have at certain times all the middlings which it ought to handle, while another may not have enough. For this reason it is apparent that the demand for the means of regulating the capacity of machines as they are

running in the mill, without reference to other machines, will in time make it an object for some of our millfurnishers to so construct and arrange the purifiers that this may be done. This might readily be accomplished by having a driving shaft on the purifier which is independent of the eccentric shaft, both of which shafts—driving and eccentric—could have cone pulleys, so that the speed of the eccentric shaft, and consequently the movement of the sieve, could be controlled at will and in a manner independent of the speed of the fan—the latter being driven from the driving shaft of the machine—the motion of which would not be changed. The writer remembers to have seen purifiers which had cone pulleys on the fan and eccentric shafts, the purpose of which was to vary the motion of the former. It is difficult to conceive of conditions which would make such an arrangement imperative, but the benefits would be derived from arrangements which would vary the movement of the sieve in a way to always keep an even and regular body of middlings passing over the sieve at all times. It should run faster when the volume is greater and slower when it is less, and in this way compensate for the difference.

In many mills, the millers do not take occasion to see that there is a uniform travel of stock over the sieve, one reason for which is that it is not always convenient to look inside, because of the way in which the doors and rick-sash are arranged. There are very few mills where there is enough help to keep the glass clean. Because of the liability of glass to get broken, and in this way to do much damage to the cloth on the purifiers and elsewhere, it might be a very good thing to fill these sash with light wood or tin panels, and then provide peep-holes with covers. This would make the matter of the inspection of the travel of the stock very simple and easy. It is clear that a miller cannot know that the sieve is covered unless he can see it, and it is equally apparent that he cannot see it unless there are proper and convenient means of inspection. Furthermore, he cannot purify his middlings unless the sieve is properly covered with a uniform and thin sheet of stock.

The writer has been in a large number of mills where the stock was all coming down in one corner of the hopper and moving along on one side of the sieve, with at least two-thirds of the cloth bare. This is barbarous work. In many mills, relics of the early times of purifiers, in the shape of 14 and 16-foot machines, are to be seen. These same machines are run, working alongside of and handling the same volume

of stock as an 8 or 10-foot machine. One of these machines has entirely too much to do or the other not enough, it being probably the large machine which has not enough to do. Eight and 10-foot machines are the best. Aside from the fact of being easier to get the proper air currents through the sieve, it is easier to get a uniform disposition thereof, independent of the condition of the travel of material.

CHAPTER XXXIX.

DUST COLLECTORS—THE ORIGINAL DUST COLLECTOR IDEA—THE OLD DUST ROOM—DUST COLLECTORS AS NOW MADE—CLASSIFICATION OF STOCK FROM DUST COLLECTORS.

It will be well to consider another product of the purifiers, one which does not usually come up for consideration in the treatment of milling questions in a practical way, and that is the material from the dust collectors. Dust and flour mills have been regarded as inseparable. The minds of millers have been changed considerably in this respect during the last few years. Dust collectors and general good construction have done a desirable service in making it possible to keep the mills free from the annoying clouds of dust. It is remembered when the Washburn dust collector was first talked of, and the speculation in regard to it. Before that time it was a common thing to say that the man who would invent a dust collector for a purifier had a fortune. But this was one of the machines which a number of people seemed to work out about the same time, and the general principles were approximately the same in all, while each had certain good points in detail. The dust from the mill, the spouts, the bins, the rolls and all should be forced into such collectors, and every precaution taken to make the mill a cleaner, brighter place than tradition and history have decreed that it should be. The manufactory of so prominent a food product, and one which strives for such purity, certainly calls for cleaner and purer surroundings than are usually allotted to it.

The dust problem and the collection of dust from the purifiers was one of the most perplexing questions with which all had to deal during the process of working out the middlings idea. Among the many methods undertaken was that of constructing dust rooms where the current of air was merely intercepted by shelves and partitions, where it had to go by circuitous routes in order to reach the outside air. This was a troublesome arrangement, requiring frequent cleanings of stock that lodged in and about the partitions and shelves, and really saved but a small proportion of the material which went into it. It was a common

thing in those days to see the outside of the mill, the roof, and frequently the surrounding neighborhood, covered with flour and middlings dust. Next came the balloon frames, covered with muslin, which promised very well, and then the muslin dust rooms, with their zigzag exteriors. But the meshes of the cloth were soon filled up, and there was trouble with back pressure on the machines.

It appears now that the dust collector problem is pretty well settled, and for two reasons. In the first place, there is less dust than there was in past years—less dusty middlings to be handled—and, second, the mechanical devices and principles involved are different from those of the earlier times. In the dust collectors of the present time that are successful, the use of flannel, with blast or suction, or a combination of the two, through this flannel, and the arrangements for cleaning it, is accepted as the proper thing. Several years ago, when middlings were dusted over a No. 12 and No. 14 cloth, when the mills were full of returns, and when so many millers tried to purify flour, it is questionable if the dust collectors of the present time could have been successful. The dust collector is the most successful, and does the best work, where the other milling operations are carried on most skillfully and intelligently. Most of the trouble with dust collectors has been where the millers have attempted to separate the flour from the air.

The dust collectors, as they are now made and put on the market, have passed the experimental stage. They are successful machines. If we were not well acquainted with the practical performances of these collectors, we could be certain of the statement—would feel justified in making it—for other reasons than those of personal observation. We have seen and know of business men who have made investments in machinery for manufacturing these collectors. They have put large sums of money in the business, have been engaged in it for several years, and are apparently prosperous. No firm can manufacture and sell at a profit and continue to manufacture, as have those engaged in this business, while making a machine that is not a practical success, and which will not do what it is intended to do. When we hear millers and others condemning a machine which has been successfully manufactured and sold for several years, and of the successful operation of which in many other mills, or in other instances we are assured, we cannot but believe that they are expressing their own incompetency at the same time they are condemning the machine. A machine which is successful in a hun-

dred instances, cannot be said to be an experiment in other cases where the circumstances are similar. No business man is going to continue to manufacture and sell an inferior machine for any great length of time.

Of the various methods for arranging collectors and attaching them to machines, that of having one for each purifier is preferable to all others. Or if, for economic reasons, this plan be not adopted, it should be borne in mind that only purifiers handling approximately the same grade of middlings should blow into the same collector, or a chamber to which collectors are attached. In this way, not only is the desired current maintained in a uniform manner for each grade of stock, but the material collected is graded. For instance, it is proper and right to run machines which handle the first middlings—middlings, say, which will pass through a No. 3 or 4 cloth—into one collector, or a chamber fitted with collectors, and the machines which handle the coarser middlings into another chamber. Of course, where each machine has its own collector, this principle is better carried out. The collections from middlings which will pass through a No. 0, 00 or 000 cloth will be red and thin, and, if the suction is properly cared for, there will be little which should not go to the feed. Particularly is this true of the very coarse middlings. As the middlings get finer, the stock becomes richer and may take a higher place in the mill, but very seldom or never higher than tailings. The material from the dust collectors is a natural tailings product, and there is a distinct relation between the dust collector stock and the material which will pass over the tail of the purifier. As we know, it is very branny in the case of the coarse machines, and whiter and richer in the case of the finer ones.

The application of dust collectors in a mill may be very broad. Their use extends wherever there is dust, and, with the facilities which they afford for avoiding waste, their use may be very extensive. A mill has been regarded as a place which is naturally dusty, where one cannot go without being covered with dust and flour. The collectors, in a measure, set all this aside. A mill may be kept clean from garret to cellar. It is not possible to keep the grinding floor in good shape, or to keep the roll frames clean, without the use of such devices. The first and greatest benefit is derived from a connection with purifiers. The next benefit comes from their attachment to reduction machinery. In times such as these, where milling products are more nearly uniform as to quality, it is important that devices of this kind be used for the purpose

of reducing the cost of the flour, which they do in the saving of material which would otherwise be wasted; and, by the way, this is an amount not inconsiderable. A continual blowing of this material out of doors is a continual blowing to the four winds of that amount of money. When we remember that the waste which goes on in flour mills at the present time will in the future represent, when saved, the larger portion of the profit, we cannot but see the efficiency of a dust collector as a saving agent. Dust is a large waste, and in collecting it we make a large saving. In time, this saving and the cleanliness of the mill, as effected at the same time, will make an appreciable difference in the cost of insurance, and as our companies organize more particularly as to the carrying of mill risks, as they study the causes of fire and loss, they will realize the safety of the dust collector to such an extent as to demand their use in mills insured by those who consider these risks in a thoroughly intelligent manner.

CHAPTER LX.

THE SIZING OF MIDDLINGS—A METHOD OF SIZING DESCRIBED—PURIFICATION OF SIZED MIDDLINGS—AUTOMATIC FEEDS ON SIZING ROLLS.

The sizing of middlings was considered carefully in a preceding chapter. The literal meaning of the word sizing—bringing to a size, making uniform in size—implies more than is usually done in the operation known as sizing middlings. It would not do to say that the idea should be carried out to the full meaning of the word. To follow it a little farther than is done into the implied idea of the definition, would mean to more nearly purify the middlings than can be done in any other way. It has been said many times that sizing is necessary in purification, and in the same connection that no system of purification can be, in any sense, complete without the use of the sizings rolls. On the same principle that we have to break wheat into small pieces in order to purify it, middlings are purer after their reduction and separation by following reels. The reduction of wheat by the corrugated rolls might, by straining a point, be called a wheat cleaning process, as it is wheat purification, and the only way that wheat can be thoroughly cleaned is to break it into middlings. Middlings are made by gradual reduction. There is no condition in the problem which would suggest that any different method be followed out in the reduction of the middlings. It takes out the flour and gives a chance to purify the remaining product in the course of a system arranged for the reduction and purification of that stock. The middl ngs, as they come from the wheat in the first place, are purer than the wheat itself, likewise the middlings which leave the sizing system, and finally, the flour which comes from the purified middlings is purer than the middlings from which it was made.

The full benefits of a system of gradual reduction will be realized when the full system of gradual reduction is introduced. While we have gradual reduction at one end of the mill—for instance on the breaks—and a less gradual method on the other end—say with the middlings—we will be able to appreciate the former, which we have, but not the latter, where we have it not.

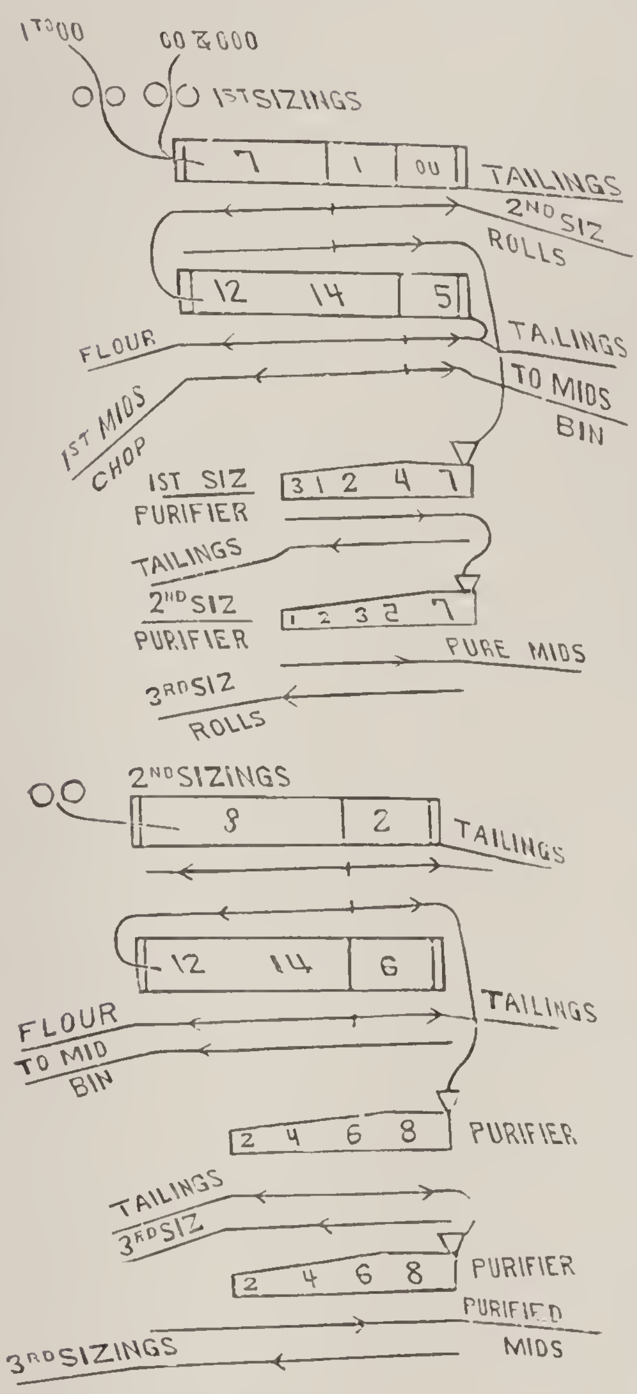
In another chapter is described a system of sizing and intermediate purification similar to the one above outlined, though somewhat more complete in detail. All of the middlings which would tail over a No. 7 cloth were divided into seven grades for the purpose of purification, and a similar number of grades for sizing. After the sizing, and previous to their entering the reels, the number of grades was reduced to five for the purpose of repurification. Each grade of middlings of the original seven passed over two machines previous to sizing. The cut-off from each last machine was sent to the next coarser grade for purification with the middlings of that grade. The sizing commenced with coarsest middlings, and all those which passed through a No. 3 cloth and tailed over a No. 4 were purified on aspirator purifiers, and from thence passed on to the next grade for sizing, where the same operation was repeated in regard to their separation and purification, as well as their continuance to the next reduction.

The finer middlings were purified on sieve machines of the ordinary form, and sized or reduced with the middlings of a corresponding grade. After each sizing, the middlings and flour which would pass through a No. 7 cloth were taken out, and the operation of purifying and sizing the larger middlings was continued until the middlings would pass through a No. 7 cloth. There were two short scalping reels after each sizing. They were used for dusting, grading and scalping the stock. At the tail of each reel there was material taken off to the tailings. This carries out the idea of the gradual reduction of middlings according to the ideas previously stated.

The sketch here given is for a much less elaborate system of sizing. This plan would readily do for a mill of 200 barrels on soft wheat. The sizing here, in the first instance, is done on a double pair of rolls—middlings from No. 1 to 0, inclusive, going onto one side, and from No. 00 to 000, inclusive, going onto the other. This grading makes it possible to do better work in sizing than when they all run together into the hopper, and in a mixed mass to the rolls. The sketch here given does not carry out the idea of the gradual reduction of middlings except in a crude way, though in a way less crude than is ordinarily practiced. All the flour and middlings which pass through a No. 7 cloth on the first reel are dusted on the second, and the desirable portion of the stock, which passes through the No. 5 cloth on the end, is commonly regarded as purified middlings. The product of the No. 1 cloth on the

first reel goes to a system of purifiers to be repurified, and from thence to the purified middlings.

The product of the No. 00 cloth goes to the second sizing rolls to be reduced. This stock should pass over an aspirator, or, if possible, over an aspirating purifier before going to this set of rolls. The reel for the second sizings is clothed somewhat finer, the tail of the No. 2 cloth going to the tailings. It will be noticed that there are two purifiers in connection with this sizing.



One frequently meets with stock similar to the cut-offs from these purifiers, which are here designated as going to the third sizings rolls, which are too rich for tailings and too poor for middlings; they should go to an intermediate set of rolls. In the sizing of the middlings on the rolls is a good chance for the display of skill in grinding or setting rolls, as sizing cannot be properly called grinding. Where the grinding is too close, the middlings are sure to be flat and difficult to purify. On the other hand, if the grinding is too open, there will be a waste at the tail and the fine middlings will be red. The writer has known an automatic feed to be placed on sizing rolls. That is the worst thing which could possibly be done. If it were possible for such a feed to automatically set the rolls, it would not be so bad; but, as we have not arrived at that point yet, we will have to trust to the skill and judgment of those handling the machines, rather than to an arbitrary feed. Where the automatic feed is used, the miller or grader cannot always be on hand to change the rolls as the feed changes, and, where that is not done, the grinding will be as irregular as the feed. An automatic feed may be a labor-saving device, but it cannot be thought that it is a money-saving

arrangement. In the case of the sizings rolls, with its use, there will be flat middlings at one time, and shortly after a rich tail. Where the miller or grinder has to change the feed with his own hand, his attention is invited to the setting of the rolls to correspond therewith.

In dropping the consideration of the generalities of this subject for the present, the writer is led to think of a question which has often been brought practically to his mind. It is why one mill is easier to run than another when the cause is not conspicuous. The fact of the reason not being apparent on casual examination does not indicate that it does not exist. A miller's experience will bring him in connection with mills, one of which may run along nicely and smoothly, and another which will be causing general trouble, and, as implied before, without conspicuous reasons. One cause of these difficulties is in the improper proportioning of the machinery, and more particularly the elevators. We will say that in the mill all of the elevators are large enough for the work they are intended to do, and that none of them are too small. But perhaps two or three scattered through the mill are too large. Say in one of these a choke occurs; it is a natural thing, and at some times uncontrollable, that such an elevator will take all it can carry. Now, this being the case, it will give the next reel, roll or other machine a large bulk of stuff, which will in turn pass it to the next elevator, which, we will say, is the proper size for a mill of the capacity in which it is placed, but having to carry the stock given to it by a much larger elevator—one unnecessarily large—it in turn is choked. The same thing may be caused by feeding into a large elevator to the extent of its capacity, or if not to that extent, in excess of the capacity of the small elevator. Thus it is clear that an elevator which is too large may cause chokes, as well as one which is too small. It is a question of proportion.

CHAPTER XLI.

PURIFICATION FOR A 100-BARREL MILL—DESCRIPTION OF DIAGRAM—A SYSTEM OF GRADUAL REDUCTION AND PURIFICATION OF MIDDLINGS.

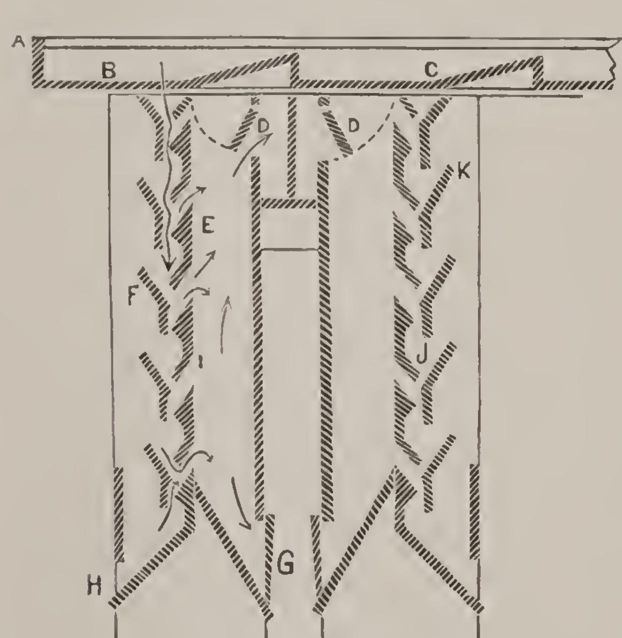
With this chapter is given a diagram of a system of purification for a small mill—say 100 barrels in twenty-four hours—and, as it is common to have a limited number of separations in a small mill, these limitations have been considered. We have shown on the diagram two sieve graders with aspirators attached, four sieve purifiers, two aspirating or gravity purifiers, two sets of smooth rolls and three reels. The middlings which go to the shaking grader *A* are such as will tail over a No. 9 cloth and pass through a No. 000 cloth. Thus we have middlings from No. 9 to 000 to purify. They are graded into five grades on shaker *A*, through Nos. 3, 1, 0, 00 and 000 cloths. Those which go through the No. 3 cloth pass to sieve machines Nos. 1 and 2, which is shown on the drawing with the two upper lines for the sieve, and the two bottom lines with arrows for conveyors. The middlings which pass through Nos. 1 and 0 cloth are each aspirated separately and then pass into a gravity separator or purifier of the Gray or Wörner pattern, or perhaps one similar to the machine illustrated in a preceding chapter, which is reprinted in this chapter for the sake of illustration. On this machine, No. 3, the middlings are regraded into four grades through grits gauze Nos. 52, 46, 42 and 36. No. 52 is equivalent to No. 2 bolting cloth, 46 to No. 1; 42 is midway between Nos. 1 and 0, and 36 equals No. 0. The middlings are thus graded into four grades on this machine, each grade falling through an independent leg of the aspirator that has a distinct suction suited in force to each grade. The purified middlings pass through the opening *H*, as shown on the sectional cut, and the impurities pass out through the opening *G*. This cut shows two legs of the aspirator, whereas the diagram cut shows the machine complete with four legs. For convenience of illustration, and as is common with most machines of this kind, the impurities are shown as coming out of the side of the machine and passing off with the tailings. This opening, as said before, corresponds with the opening *G* on the sectional cut. On each machine

there are four grades of these impurities, varying in size and specific gravity according to the grading on the sieve above. The purified middlings from this machine come out in four distinct streams and size from grade 2.

The middlings which pass to purifier No. 4 are those which pass over the No. 0 cloth on the grader, and through the Nos. 00 and 000, each grade being aspirated separately as before, and thence to the purifier sieve to be graded over No. 32 grits gauze, a size which stands midway between Nos. 0 and 00 bolting cloth. No. 28 equals No. 00, No. 26 stands between Nos. 00 and 000, and No. 22 equals No. 000. Thus these middlings are graded through Nos. 32, 28, 26 and 22 grits gauze.

The purified middlings from this machine make up grade No. 3, and the impurities pass off with the tailings as before.

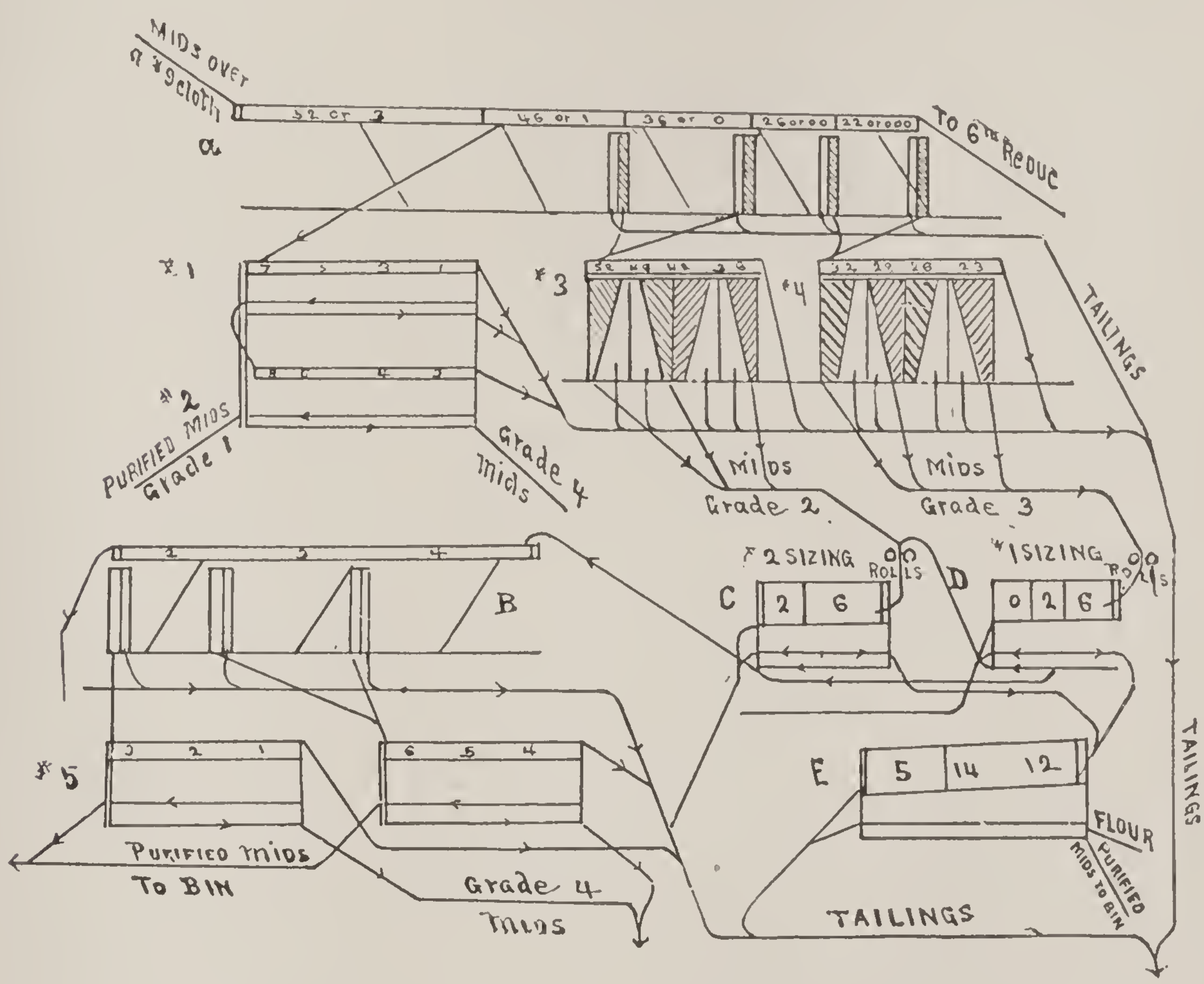
To return to machines Nos. 1 and 2. It will be remembered that the middlings which go to these machines pass over a No. 9 cloth and through a No. 3. Thus we have middlings from No. 9 to 3 to take care of. This is a wider range of size than would be recommended in a mill



more complete, but this will answer the purpose of illustrating a system which will be made more complete in a future chapter. Machine No. 1 is clothed with Nos. 7, 5, 3 and 1 cloths, and machine No. 2 with Nos. 8, 6, 4 and 3 cloths. There are two conveyors under each machine. The upper one in each runs to the head of the purifier, and the lower one to the tail, as indicated by the arrows. The tail of each machine goes with the tailings, as does the cut-off from the first machine. If it be necessary to take some tailings from this conveyor, as it probably would be, the tail of the sieve being clothed with No. 1 cloth, while the middlings to that machine pass through a No. 3, it can be done. In this way the middlings from this machine to No. 2 can be made reasonably clean, which will give the second machine a chance to do good work. It will be noticed that there are no finished or purified middlings taken from the first machine. They all go to the second; that is, all excepting the cut-off. Middlings from the upper conveyor of machine No. 2 make up one

grade of purified middlings. The product of the bottom conveyor, or cut-off, would form what is called grade No. 4, which is an off grade of middlings not good enough to be reduced to patent flour. This disposition will be considered later.

Middlings of grade No. 1 may be regarded as purified and ready for reduction into flour. Middlings of grades No. 3 and 4 have had the impurities of less specific gravity than the middlings themselves removed, but they still contain germ and middlings with adhering portions of bran and other impurities. This separation is made by the smooth iron rolls and the reels and separating devices which follow. This purification



process commences with grade No. 4, which is sized or broken on smooth iron rolls, from whence they pass into reel *D*, which is clothed with No. 6 cloth at the head, No. 2 in the middle, and No. 0 at the tail. The No. 0 tail cloth fixes the setting of the sizing rolls for this grade of middlings. It is the intention to have the largest middlings on this sizing uniform with grade No. 3; hence the smaller ones are taken through Nos. 6 and 2 cloths, the larger through No. 0. The conveyors under this reel are arranged so that the undesirable portion going through the tail of No. 0 can go to the tailings rolls. This is done by closing slides

at the tail of the upper conveyor, thus sending only the best middlings of the larger size to grade No. 3. Middlings which pass through the No. 2 cloth, and the undesirable portion of No. 6, pass to grader *B*. The cleaner portion, which passes through No. 6, and contains the flour and fine middlings made in sizing this grade, passes to reel *E*. It will be seen that the sizing of the fourth grade of middlings has in mind their reduction to a grade equivalent in size to grade No. 3, and at the same time the removal of the impurities which were the size of the original middlings. In sizing from Nos. 000 and 00 to Nos. 1 and 0, the rolls will not be set so close as to make flat middlings, their setting, as intimated before, being influenced by the tail of the No. 0 cloth of reel *D*, at the same time keeping the middlings which pass through this cloth round and sharp.

We now have middlings of grade No. 3 to deal with. They are sized with reference to tail, product and cut-off of the No. 2 cloth on the tail of reel *C*, the product of this No. 2 cloth going to shaker *B*, and the tail and cut off thereof going to the tailings. The product of the No. 6 cloth of this reel goes to reel *E*. It contains the flour and fine middlings made in sizing this grade of middlings.

Reel *E* separates the flour from the fine middlings made in sizing grades Nos. 3 and 4 of middlings. The head of this reel is clothed with Nos. 12 and 14, and the tail with No. 5. Perhaps it would have been better to have clothed this tail with No. 6, as that is the number through which the middlings originally passed; but, as they were then mixed with coarser middlings in reels *D* and *C*, they would bolt much sharper and freer than when by themselves in reel *E*. A No. 6 cloth on reel *E* would tail over good middlings which would pass through a No. 6 cloth with the stock of reels *C* and *D*. Leaving the clothing of reel *E* as it is, in event of the stock bolting through the tail of No. 5 being thin and red, it could pass with the tail to the tailings rolls by closing up a desired amount on the upper tail conveyor. The desirable portion of flour, the product of Nos. 12 and 14, can be taken from the top conveyor as indicated. The cleaner portion of No. 6 and the cut-off of the flour cloth pass off by means of the bottom conveyor as purified middlings. These are the cleanest, brightest middlings in the mill. Their purity is owing to their purification in their original size as represented by grades Nos. 3 and 4, and the subsequent purification by the sizing rolls and the following reels.

It will be remembered that the impure product of the No. 6 cloth of reel *D*. together with that which goes, through the No. 2 cloth of the same reels and the cut-off of No. 6 cloth, and the product of the bottom conveyor under the No. 2 cloth of reel *C*, passes to shaker *B*. This shaker, or grader, though of smaller dimensions, is of the same design as grader *A*. This grader, it will be noticed, is clothed with Nos. 4, 3 and 2 cloth. Each grade of middlings passes through an aspirator which is of the same construction as one leg of the purifier already described. the lighter impurities, as before, going with the tailings, and the products going to the sieve purifiers below. The middlings passing through the Nos. 3 and 4 cloth go to one machine, and those through the No. 2 cloth to No. 5 purifier. The tail of No. 2 cloth on the grader goes to the tailings. The middlings which go through the No. 4 cloth have been dusted over a No. 6; thus this grade is in size from No. 6 to 5 inclusive. The machine which handles this grade of middlings and those which pass through the following No. 3 cloth, is clothed with Nos. 6, 5 and 4, the tail of No. 4 going with the tailings, and the product of the upper conveyor, as purified middlings, to the middlings bin. The cut-off represented by the product of the bottom conveyor goes with the middlings of grade flour. The tail of this machine over No. 4 cloth would be richer, perhaps, than desirable, but on general principles the tails and cut-off from the machines and reels, as represented in this diagram, run richer than they would were more elaborate arrangements provided for taking care of the various products.

Machine No. 5 is clothed with Nos. 2, 3 and 1 cloth, the desirable portion on the upper conveyor going as before with purified middlings, and the cut-off and tail with the tailings. There are some who would say: "Why not put the two grades of middlings from this sieve *B* on one machine and then repurify them on the second?" In the first place, better work can be done by grading the middlings into a larger number of grades, and then purifying them each on one or two machines, than by lumping the grades and passing them over a larger number of machines. By the former method the suction can be adjusted so as to recognize smaller differences between the specific gravity of the middlings and the impurities. Of course, there is such a thing as carrying this too far, and the only difference the writer would suggest from the method represented, would be to place an extra machine under each No. 5 and 6, getting the benefit of the scalping and sieve action of the first machines, together

with their suction, to be followed by the sieve action and stronger suction of the second machine.

The size of purifiers is entitled to more consideration than is generally given. For a mill of this size and equipment the machines would naturally be quite small. They should be of such a size that the quantity of middlings which passes over them should entirely cover the sieve. This can, in a measure, be regulated by the clothing, having a larger or smaller proportion of fine cloth at the head, according as the stream of middlings is large or small. It is not possible to fix the size of the machines or the proportioning of the various numbers of cloth unless one knows the amount of middlings which will be made from a given quantity of wheat, which amount is regulated by the quality of the wheat as to its hardness or softness, and the quality of the grinding, each being variable. Quantities being equal, a machine which handles coarse middlings should be smaller than one which handles fine middlings. In a gradual reduction roller mill there is a much larger proportion of coarse than fine middlings; therefore it is safe to make the machines for the different middlings of the same size, allowing the proportioning of the amounts of the various numbers of cloth to make up for the difference in volume and sieve capacity required.

Reference was made to middlings of grade No. 4, which are not disposed of in the run of the material shown on the diagram. In a mill of this size and equipment, these middlings, which, as said before, are of a little off grade—not good enough for direct reduction into patent flour and too good for tailings—should pass through a set of smooth iron rolls, reducing them enough to alter the relative difference of size between the good middlings and the impure stock. They should then go to a short reel, say four or five feet long, clothed with No. 4 or 5 cloth —4 for soft wheat and 5 for hard. The tail, and perhaps a cut-off from this reel, would go with the tailings, and the remaining product of the reel would pass into a flour reel clothed with flour numbers at the head, say Nos. 12 and 14, and No. 7 or 8 at the tail. The better portion of stock from this cloth and the cut-off from the flour cloth, would pass off and into the stock which goes to make up the purified fine middlings. The cut-off and tail from the scalping cloth of the flour reel would go to the set of smooth rolls which handle the product of the tailings roll reel; that is, that portion which would pass through the scalping cloth of that reel.

The next step in purification would be in connection with a reduction to flour, but will not be considered in this chapter. The reduction in the methods of purification has been gradual, and such reductions have been made on middlings of approximately the same size. It would be desirable to have this classification still closer, and to continue it through and as a part of the final methods of reduction, though it will not be possible in a mill of this size. It was intended to say something about a system of clothing, as applied to sieves and reels used as a part of the purification methods, but, as the meaning can be better illustrated by another diagram which is to follow, this will be reserved until that time, simply saying that such a method can be formulated and the formula used to the exclusion of all guess-work and experiments, the clothing of a machine or reel being a matter of foresight, with the certainty of a definite result.

CHAPTER XLII.

THE PURPOSES OF A DIAGRAM AND A DESCRIPTION THEREOF—A DIAGRAM WHICH IS TO BE USED FOR THE DEVELOPMENT OF THE IDEA OF GRADUAL REDUCTION AND PURIFICATION—A DESCRIPTION OF THIS DIAGRAM.

With this chapter is given another diagram. It may be said that a diagram should be so drawn as not to need lengthy explanations. So far as the run of the stuff is concerned, this may be true, but merely knowing the run of the material does not give its purposes or intentions. One not only wants to know where the stuff goes, but why it goes here or there. So far as real knowledge goes, this is the valuable portion, if there is any.

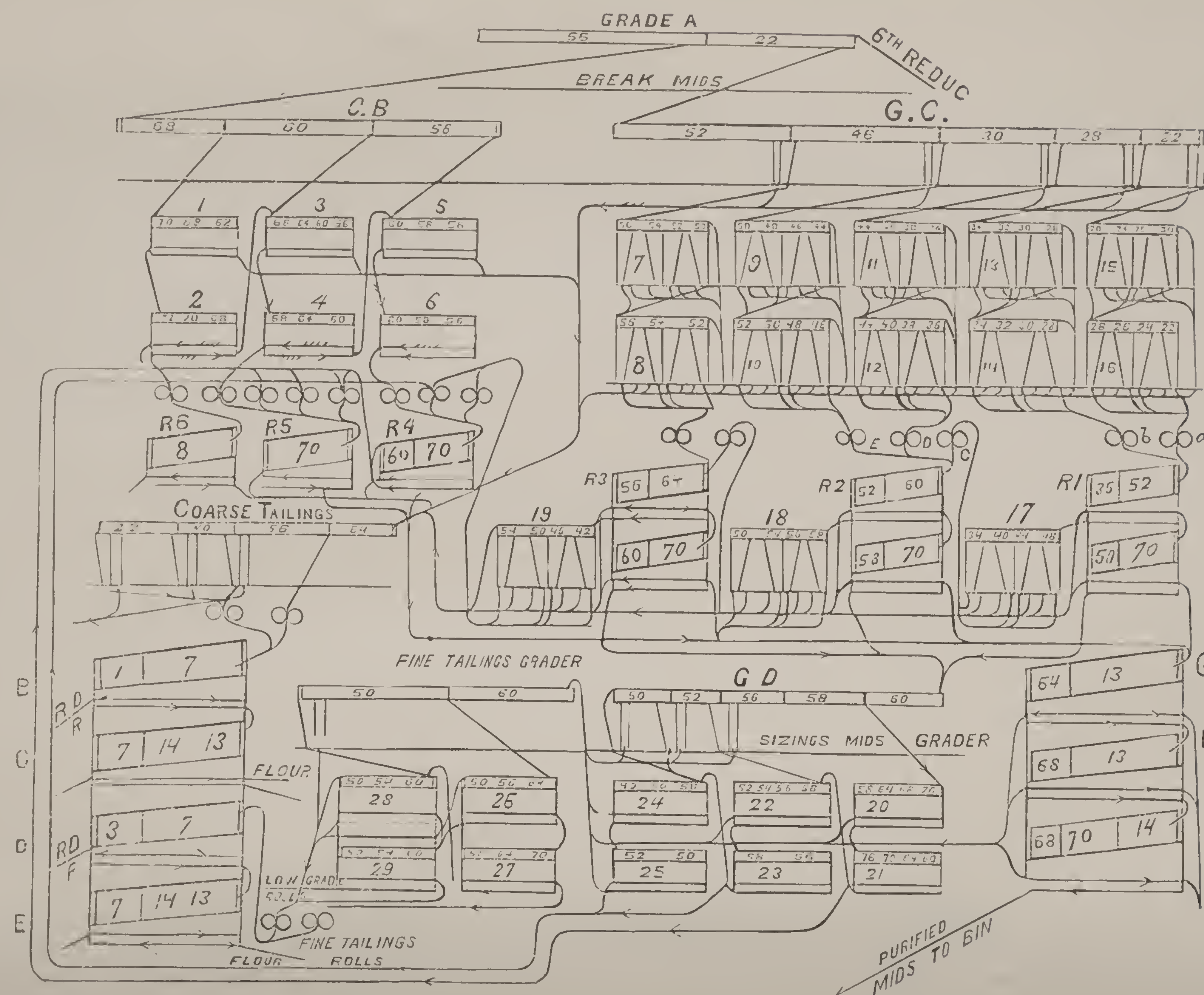
In this diagram are shown graders, purifiers of the sieve and suction form, air purifiers of the aspirator pattern, rolls and reels. It is the purpose of the writer to show that all alike are purifiers—that purification means purification by whatever means, and that such means are purifiers. There is a general understanding among millers that middlings are purified solely for the purpose of making patent flour, and that if they cannot be purified to such an extent as to make them clean enough for such flour, they need not be purified at all. This is limiting the use of purifiers. The purpose of milling in general is to make pure flour, and where that is not altogether possible, to come as near such perfection as possible. There is no exact or dividing line between patent and the best bakers' or clear flour. Making good patent flour alone is not the end sought for in milling. Where middlings have not been made clean enough for pure or patent flour, they should be made as pure as possible for the bakers' or clear flour. There is no good reason for not doing the best we can for middlings when they cannot be made clean enough for patent flour. It is as necessary and as much to the advantage of the miller that they should be subjected to such action under these circumstances, as if they were going into the cleanest and best flour.

In this diagram some of the poor stock is subjected to the action of the purifying devices for the purpose of making a better grade of clear or bakers' flour than would be possible without such action.

The diagram which is to be described in this chapter is more elaborate than the writer can expect to see put into actual practice. Its value is to be derived from the exposition of the principles involved; and it is from this one that all of the more simple diagrams are to be constructed, even when only three or four machines are to be used.

There is a constant demand or incentive for improvement—advancement in everything. It has been shown through the experience of millers that it is possible to make a certain proportion of pure flour, and therefore the line of advancement in the quality of milling products is in the direction of a larger proportion of pure flour on one hand, or an improvement or advance in the purity of the lower grade on the other. It has been said before that in order to make a pure flour there must be a pure something else to begin with. Other things being equal, the purity of clear or bakers' flour will be more nearly possible in proportion as the stock out of which it is made is pure. As the grades of stock approach purity, the flour will be proportionately pure. With this in view, it is easy to see that the improvement of the clear or bakers' flour will be met by the purifiers, and the idea that the purifiers belong to the patent flour alone will be wiped out. Tailings from purifiers and the residüum from the various purifying devices are frequently sent in a conglomerate way to the smooth rolls, and the term tailings rolls stock has a wide, mixed and uncertain meaning.

But to cut this general talk off short, we will go directly to the consideration of the diagram. In the first place, the middlings are supposed to tail over No. 9 cloth, and go on to grader *A*, where they are divided into two grades through Nos. 56 and 22 grits cloth. The product of No. 56 goes to grader *B*, and that of No. 22 to grader *C*. No. 22 being the coarsest scalping number, the tail of this grader goes to the sixth reduction. This arrangement would work all right when there were no holes or leaks in the break scalpers, but when the middlings come directly from the middlings scalpers, the product of such holes and leaks shows up on the graders. At the same time that it is not convenient or desirable to stop the mill for such small disorders, on the other hand it is not right to send the coarse break stock, which has found its way to this point from, say the third or fourth reduction, to this lower or sixth reduction. One way to arrange this is to aspirate this tail stock by means of a strong suction, and in this way the heavier or break stock which tails over can be sent to some suitable break, say the third or


GRADE A
6TH REDUC
BREAK MIDS
C.B
G.C.
R6
R5
R4
R3
R2
R1
COARSE TAILINGS
FINE TAILINGS GRADER
G D
SIZINGS MIDS GRADER
FLOUR
LOW GRADE
FINE TAILINGS ROLLS
FLOUR
PURIFIED MIDS TO BIN
B
C
D
E
G
H
I

fourth. There is a very large proportion of light, fly-wing bran tailed off from this grader *A*. This is one good thing about a grading sieve—that the light, fine, fluffy stock is tailed off, while with a reel it is driven and forced through the cloth with the middlings, thus rendering the work of purification more difficult. After the stock is graded into two general grades in the manner described, it is subdivided on graders *B* and *C*. The former is clothed with Nos. 68, 60 and 58 grits cloth. The product of this grader is purified on purifiers of the ordinary form. The three numbers in their order, are equivalent to Nos. 6, 4 and 3 cloth. The product of the first division of this grader goes to machine No. 1, clothed with Nos. 70, 68 and 54. This grade of middlings, it will be remembered, tailed over a No. 9 cloth. Thus we have middlings from No. 9 to 6 cloth to handle. The product of the first machine goes to the second, no finish being taken from this machine. The second machine is clothed with No. 8 cloth and Nos. 70 and 68 grits gauze. Before speaking of this machine it might have been well to have said that the tail and cut-off of the first machine goes to the coarse tailings grader. The product of the upper conveyor of the second machine is the finest grade of purified middlings, and the number of this grade, speaking with reference to their sizing—it being the intention to commence with the coarsest middlings and size down—is No. 6, as indicated by the number of the sizings reel immediately below on the diagram. The cut-off from this purifier goes to the first machine handling the next grade of middlings. The purity of this stock will be influenced by the quality of the cut-off taken from the bottom conveyor of the No. 1 purifier.

The first machine for the next grade of middlings is No. 3. The middlings from this grade are those which will tail over No. 68 and pass through No. 60, that is in size from No. 4 to 6, cloth numbers. The disposition of the material going to the machines for this grade is the same as for the first grade. The product of the upper conveyor goes to machine No. 4, and that of the cut-off and tail, as indicated by the bottom conveyor, goes to the tailings. The upper conveyor of machine No. 4 makes the fifth grade of middlings, as indicated by the number of the sizings reel below. The tail of the machine and product of the bottom conveyor go with the third grade of unpurified middlings to machine No. 5. This third grade of unpurified middlings is handled substantially in the same manner as those before mentioned. This grade is the product of No. 56. The method of running the product of the bottom

conveyor of the second machine of each grade to the first machine of the next grade has a two fold object; that is, to give this stock additional purification, and principally to be able to stock up the next machine. For example, the first machine of the second grade may have a stock too light to cover the sieve from head to tail, and only the middlings from its grading cloth above are taken, in which event it will be easy to throw over stock from the bottom conveyor of machine No. 2, which is the last machine of the first grade. In this way the tail cloth on all the machines can be properly covered.

In a previous chapter it was said that a formula could be used to the exclusion of all guess work and experiments in the clothing of purifiers, the whole matter being arranged with reference to the certainty of a definite result. This is as good a place as any to explain what was meant. It will be remembered that the first grade of middlings those which will tail over a No. 9 cloth and pass through a No. 68. This will indicate the size of the middlings to be handled and aid in fixing the numbers of cloth for this size of middlings. The first machine of each grade is clothed with a tail number slightly coarser than the cloth through which the middlings passed in coming to that machine. For instance, the first grade came through 68; the tail number for that grade is 64. The second grade comes through 60; the tail number on that machine is 56. The experience of millers in clothing machines shows the wisdom of such a course. On most of the machines the head number is slightly finer than the cloth through which the middlings of that grade originally passed. This proceeding holds up the middlings on the sieve so that there is no danger of losing a larger portion of the stock before it reaches the tail of the sieve, thus leaving part of the cloth bare. The grading number generally comes a little past the middle of the machine. Another reason for making the head numbers finer than the grader number is that in all the machines after the first there are middlings coming to that machine from the next finer machine, which are finer than the middlings of the grade number. The second machine of each grade is clothed finer, head and tail, the tail number being the grading number and the head number the number of the next finer grade. For instance, the tail number of the bottom machine of the second grade is No. 60, which is also the grading number of this series of machines; that is, Nos. 3 and 4. The head number of this No. 4 machine is 68, which is the grading number for the next finer grade of middlings.

To carry this illustration farther, notice the numbering of the machines under grader *C*. The middlings which go to this grader are those which tail over No. 56 and go through No. 22. The numbers on the sieves are arranged with reference to these grades. The machines which handle these grades are clothed as before with reference to the size of middlings as indicated by the number of the cloth over which they tail and the number through which they pass. The head number of the first machine for each grade of middlings is slightly finer than the number for the next preceding grade. This is done to cover the contingency of the finer middlings being carried over. The tail number of such machines is slightly coarser than the grading number. This is done because there will be coarser middlings going through the grading cloth when impelled or forced by a body of larger and coarser middlings which go over to the next numbers or grades.

In clothing the tail of the second machine of the series, it is possible to make its numbers the same as the grading numbers and yet preserve a light tail, as the middlings are cleaner and more free from impurities than when going on the first machine; thus they will more readily pass through the cloth. The head number of these second machines is generally approximately near the next preceding grading number. The intermediate space between the head and tail number is filled in with intermediate numbers. The diagram will be followed out in the next chapter.

CHAPTER XLIII.

CONTINUATION OF DESCRIPTION OF LAST DIAGRAM—GRADUAL REDUCTION AND INTERMEDIATE PURIFICATION OF MIDDLINGS—CLOTHING OF THE REELS WITH REFERENCE TO THE SIZING—CLOTHING OF THE PURIFIERS AS INFLUENCED BY THE REDUCTIONS—PURPOSE OF THE GRADUAL REDUCTION OF MIDDLINGS—TAILINGS PURIFICATION—DISPOSITION OF PURIFIED MIDDLINGS.

In the last chapter the middlings from grader *B* of purification diagram were traced as far as the sizing rolls. The middlings from grader *C* are graded through Nos. 52, 46, 36, 28 and 22, and are purified by aspirator purifiers, as described in a previous chapter. The handling of each grade is the same with reference to the purifiers, the middlings being graded into four grades on each machine, and the suction therefore graded to each size or specific gravity. Thus there are four products of middlings, and four of impurities, from each machine. The impurities go to the tailings grader and the middlings to the sizings rolls. The five grades of middlings from grader *C* are contracted into three grades after sizing, though the middlings from each machine run to separate rolls for sizing. It is necessary that this division as to grades be preserved in sizing, in order that the rolls may do their work properly, such work being impossible where the middlings going to the rolls are not uniform in size. This preservation of the different grades in sizing may be noticed by referring to the rolls in connection with the grader, where it will be seen that each grade is sized by itself, while the middlings from the No. 28 and 22 cloth are spouted together after they are sized; likewise the distinct grades from Nos. 46 and 36. Accordingly, it will be seen that there are six grades of middlings as they go into the reels after sizing, and eight grades as they go to the sizing rolls. As it is unnecessary to follow out the course of the stock on each of the machines under grader *C*, it is well to go on with a description of the sizings, hesitating only to call attention to the aspirators under this grader, there being one such to each division. Thus the middlings are aspirated in a body before going to

the purifiers below, the course of the stock at such points being clearly marked on the diagram.

Each grade of middlings having passed through at least two purifiers, which contemplate the separation of the material detached from the middlings, which is either less in specific gravity or larger in size than the middlings, their purification as to the removal of adhering deleterious stock, and such as is of different structure or composition than the middlings, remains to be considered. As previously described, this is done by the sizing rolls and the separating devices which follow. In the system of sizing diagramed, commencement is made with the coarsest middlings and the process continued until all the purified middlings will pass through a No. 7 cloth. The finer middlings of the different grades come in in their regular order as indicated by their size. The coarsest middlings, being those which come through the tail of grader *C*, are sized first. In this instance those which come through Nos. 22 and 28 are sized on rolls *a* and *b*, respectively, after which they pass to reel 1, clothed with Nos. 52 and 36. The setting of rolls *a* and *b* is influenced by this tail number, it being the purpose to tail over impure stock at this point. It will be noticed that the tail number on this reel corresponds to the grading number for the next finer grade of middlings; that is, No. 36. Thus middlings 28 and 22 are sized down so as to be uniform with those of the next grade. The middlings which pass through the No. 52 cloth go to the next lower reel. The desirable portion of that which goes through the No. 36 goes to purifier No. 17. A portion of the middlings which go through the tail of No. 36 may be too poor to go to this machine, in which event they can be sent with the tailings from this reel, by closing slides under such undesirable portion, which, as indicated by the conveyor, will start it in the proper direction. The middlings which go to machine No. 17 from this reel 1 are those which tail over a No. 52 and go through a No. 36 cloth. The numbers on that machine are from 48 to 34. Such head and tail numbers are slightly coarser than the head and tail numbers on the reel. This purifier is of the aspirator pattern, and its product of middlings goes to roll *C*, which is of the series of rolls which handle the next finer grade of middlings than those out of which these were made. The product of the No. 52 cloth of reel 1 is dusted out on No. 70 in the next lower reel, the desirable portion of which product is sent to the series of reels below which remove the flour that is made in sizing. Next to the No. 70 cloth is No. 50, the middlings of this reel hav-

ing originally passed through 52. This tail number being coarser, a part of the product near the tail of this cloth will go with the tailings. The other portion of the product of this cloth, which is a grade of middlings which will tail over No. 70 and pass through No. 50, goes to the grader *D*, which grades the fine middlings from the sizings. If the entire product from the No. 70 should not be clean enough to send to the reels which dust out the flour, the impure stock from the 70 can be dropped into the bottom conveyor under this reel and sent to the grader *D*, on which system it will be purified. The two coarsest grades of middlings, those which go through Nos. 28 and 22, having been sized down to the next finer grade, No. 36, it remains to take Nos. 36 and 46 and size down to grade 52. This is done on the rolls *c*, *d* and *e*, *c* taking the middlings from purifier No. 17, or those which will size down, and the rolls *d* from No. 36, and *e* from No. 46. The stock from these rolls goes into reel 2, the head of which is clothed with No. 60 and the tail with No. 52, 52 representing the next finer grade of middlings. The desirable product of No. 52 which had tailed over No. 60, goes to purifier No. 18, to be purified before going to the next sizing. The product of the No. 60 of reel 2 goes into next lower reel under the same circumstances as does the corresponding stock on reel 1, into the reel below it. The head number of the reel below reel 2 is 70, in common with the same reel under 1 and 3, this being the number through which clean middlings and flour are taken. The tail number of these lower reels is influenced by the head number of each upper reel, being slightly coarser. The reason for its being coarser is that the lower reel does not have as sharp stock to handle as does the upper, and, for that reason, a slightly finer number on the upper reel will bolt as coarse as the slightly coarser number on the lower reel; and, in any event, if the tail cloth of the lower reels should yield poor material near its tail, it can be sent off with the tailings by closing slides under the conveyor, in number and position as indicated by the quality of the stock. The numbers on the purifiers intermediate between the sizings are influenced by the head and tail numbers of each of the upper reels which they follow. The head of reel 2 being 60, that on purifier No. 18 is 58, and the tail number of reel 2 being 52, the tail number of the corresponding purifier is 50. The head and tail number of each purifier is thus slightly coarser in each instance. The next sizing is from No. 52 to No. 56, as indicated by the tail number of the upper reel which bolts out the stock from the sizing, the general movement of the

material having the same purpose as in the bolting of the previous sizings. For this reason it is not necessary to follow it out here. It may be well for the reader to notice the relation which the numbering of this reel and the following bears one part with another, and to the previous and following reductions. It was stated early in the description that it was the purpose to size these middlings so that all would pass through a No. 70 cloth, and it may be noticed now that all the numbers on the reels are drawing closer to this number. The head number of the upper reel of the sizing was 52; the head number of the third is 64. The tail number of the second reel of the third sizing is 60. In the fourth sizing the numbers come so close together that a smaller number of separations is required; consequently one reel does the work. This is true also of the fifth and sixth.

Before going on with the sizings of the middlings from grader *B*, it may be well to call attention to the fact that the middlings from the first three sizings—those which tail over the No. 70 cloth of each of the bottom reels, which bolt out the stock from such sizing rolls and pass through the tail number of such reels—pass to grader *D*, which grades for a distinct system of purifiers for these sizings middlings. The size rises from 60 to 50, as indicated by the tail numbers of the bottom reel of each series of sizings reels. The three tail sizes on this grader are aspirated before going to the purifiers. The machines which come under this grader are arranged with the same purpose as to numbering and movement of stock as described for grader *B*. The stock from the finest middlings—that which comes through a No. 60—goes to the rolls which size No. 60 middlings from grader *B*, and the coarser middlings which come from grader *D* go under grader *B*, which sizes a corresponding stock.

To go on with the sizing, commencing with the stock which leaves purifier No. 19, which was the intermediate purifier between the third and fourth sizings, it is easy to see that the purpose is the same as with the previous sizings; that is, to break the middlings down to the next size, or from 5 [illegible] he tail number on reel 4, and the grading number of the next finer middlings. The product of the No. 70 of this reel goes to reels marked *G*, *H*, *I*, as do also the product of Nos. 70 and 8 of the fifth and sixth sizings.

We have now followed out the sizing of the middlings from the coarsest to the finest, and brought them all to a uniform size; that is, so they will

tail over a flour cloth and pass through a No. 70. This, as a bare fact, may not appear significant of anything extraordinary, but such a method is what gives their wonderful purity to the high grade flours of Hungarian milling. By the method as outlined, the middlings are first purified in their original size as they leave the graders, and, after being purified in this form by the various machines, they pass to the smooth rolls, and by this means are sized down one grade at a time, gradually and carefully, until a uniform size is reached. Following the first three sizings, the coarser grade of middlings is purified by air purifiers, and the finer—those which will tail over a No. 70 cloth—by suction machines of the ordinary form, after having been previously graded on a sieve grader. The last sizing—that is, of the middlings which come through a No. 68—is bolted or scalped through a No. 8 cloth. This is done for the purpose of giving additional purity to the middlings which originally passed through No. 68. If these middlings were bolted through a cloth uniform with those of the reels of the previous sizing, there would be so little work to be done by the sizing rolls that little additional purity would be added to this stock. If the numbering of this reel was made uniform with the others there would be mathematical uniformity as to the size of the stock, but it would mean irregularity and uncertainty as to the uniformity in quality of the products. Such a course would be carrying a good rule too far. It would be sacrificing a principle for a rule. There is no place which will show the natural development of the necessary numbers on reels, scalpers and purifiers any more clearly than this sizing and purification system; and by such a system the proper setting of the rolls, as to their closeness, is clearly defined by the tails of the reels which immediately follow them. If such tails are lumpy and hard, they show that the rolls are too far apart; if flat and white, that they are too close together. Sizing too fast or with close set rolls makes flat, flaky middlings which cannot be purified. If middlings have been once flattened in this way, the purifier or roll can do little for them afterward. The roundness and sharpness of the middlings as they leave the reels will show clearly that the reels are not too close. The same stock will show sharp, and at the same time red and foxy, if they are too far apart. If the sizing rolls are properly adjusted, the product of the reels will be round and bright at the same time that the tails are thick and red. This method of sizing and separation, together with purification between sizings, lies in the line of progress in the mills of the future.

The stock which passes through the No. 70 cloth of the sizing reels, and which contains the fine middlings and flour, is bolted out on the three reels *G*, *H* and *I*, the tail of which reels goes to the tailings graders. The flour is taken off at the head through a No. 13 cloth on the first two reels, and No. 14 on the third. The product of Nos. 70 and 68 is the middlings which are to be reduced to patent flour.

Coarse and fine tailings graders are shown in this diagram, but the fact that such stock is graded and passed through purifiers does not imply that there is an intention to make patent flour of it. It means that there will be a better grade of flour, of whatever kind, made after such a process than there would be if the purification were not attempted. As said before, purifiers should not necessarily imply the manufacture of patent flour. What they do imply is an improvement in the stock which they handle, no matter how low it may be in its original state. The stock which goes to the coarse tailings contains a large proportion of small, thin, soft bran and a small proportion of thin, nubby stock. The effect of a grading sieve will be to make a good separation. The coarse tailings grader is clothed with Nos. 64, 58, 40 and 22. The product of 64 goes directly to the smooth rolls, and from the three remaining numbers through the aspirators, and thence to smooth rolls. With this quality of stock the aspirators can draw heavy enough to take out all of the light stock, leaving only the heaviest stock to be reduced. The entire product of the flour stock from this grader is bolted out on reels *B* and *C*. The fine tailings grader has little stock to handle from the part of the mill described by this diagram, as it handles only the tails from reels *G*, *H* and *I*, and the tails and cut-offs from the purifiers on grader *D*. But there are other places in the mill which would furnish more stock for this grader. A part of the stock which went to the coarse tailings grader might with equal justice have been sent to this grader. As can be seen, the clothing of this grader is 60 and 50, and there are under it four purifiers, two for each grade, the numbering of the cloths of which is influenced by the grading numbers and the reels from which such stocks came. The movement of the stock on these machines is identical with those previously described under those graders. The product of each grading number, after passing through the purifiers, goes to a distinct pair of rolls, after the reduction of which the stock is united and bolted out on reels *D* and *E*.

CHAPTER LXIV.

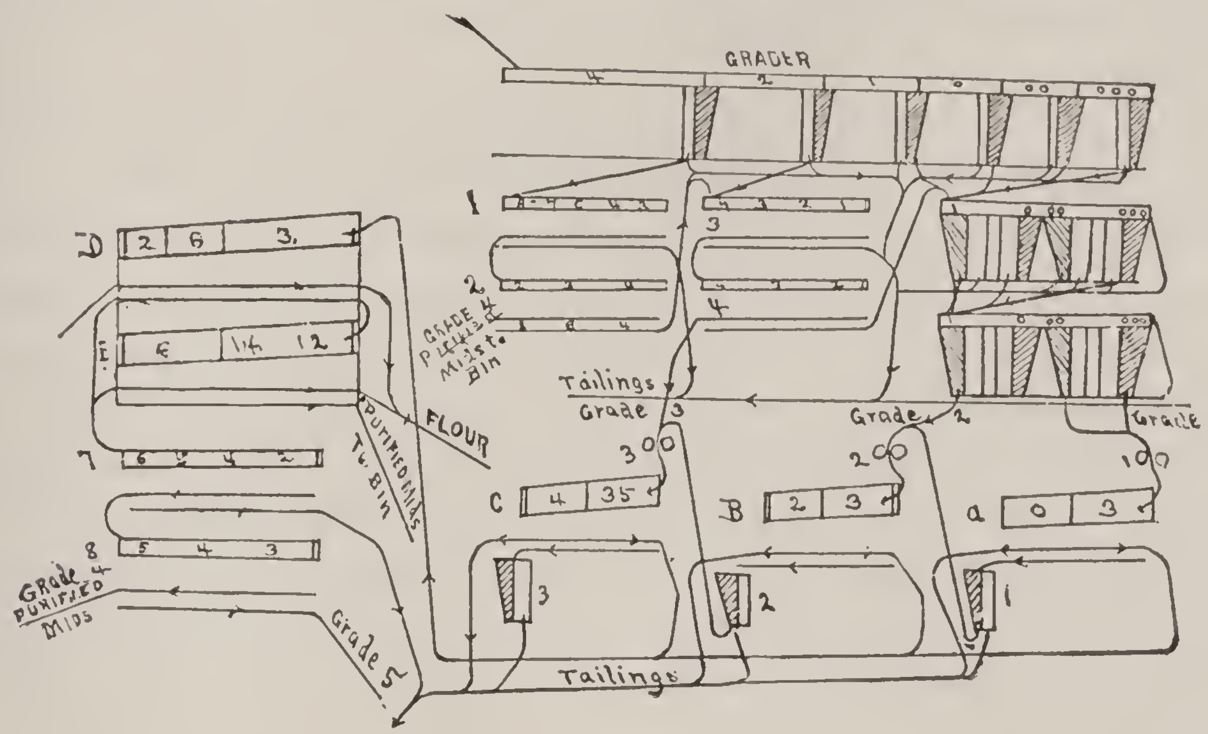
PURIFICATION DIAGRAM FOR A 200-BARREL MILL—CLASSIFICATION AND PURIFICATION OF STOCK—DESCRIPTION OF THE DIAGRAM.

In the diagram which is given, a system similar to the more elaborate one described in the last chapter, is shown. It covers all the main points given in the larger and more elaborate diagram. We have shown one grading machine, six purifiers of the ordinary pattern, two aspirating purifiers of the Wörner or Gray pattern, three single aspirators, three pairs of smooth rolls with their scalping reels, and two flour reels. The middlings are those which will tail over a No. 9 cloth and pass through a No. 000. It has, no doubt, occurred to some of the readers that this represents a wide range of sizes, even to put on a grading machine. This method had its origin earlier in the process of milling than the purification of the middlings, and, as it is not a vital question with reference to their purification, it need not be considered here.

As will be seen, the middlings are graded into six grades by the grading machines, each grade being aspirated separately before going to the purifiers. The aspirating of the middlings at this point aids not only in their purification in the direct way of removing fibrous and other impurities, but it is an auxiliary method, in that it removes any remaining portions of flour or dust which may have remained after scalping, or which were made in the travel of the middlings subsequent to that process.

After the middlings are graded into these six grades they are contracted, as to number, into three grades, the original larger number having been arranged for the purpose of giving a nicer distinction in the arrangement of the suction on the aspirators. If the bulk of middlings going through these aspirators represented varying sizes, and, consequently, a wide range as to specific gravity, the suction could only be arranged with reference to the lighter impurities of the lightest middlings in that stock. By arrangement into this larger number of grades, the suction can be more nearly adjusted so as to meet the exact difference between the middlings of each grade and the contained impurities.

The first two grades coming from the grader and aspirator go each to a separate series of purifiers. The first is composed of Nos. 1 and 2, and the second of Nos. 3 and 4. The first machine is clothed with Nos. 8, 7, 6, 4 and 3, and the second with Nos. 8, 6 and 4. No finish is taken from the first machine, the desirable portion of the product being sent to the second. The poorer part of the cut-off, if there be any on this first machine, goes to the tailings. Grade 4 of the purified middlings, which is the product of the second machine, goes to the purified middlings bin. The middlings of the next grade are handled on machines Nos. 3 and 4, the third machine being clothed with Nos. 4, 3, 2 and



1, and the fourth with Nos. 4, 3 and 2. The travel of the stock on the third machine is relatively the same as on No. 1. This statement will apply to the fourth, with the exception that the product of purified middlings in the latter instance goes to the third sizing rolls or to middlings of grade No. 3, which is the same. The product of the bottom conveyor under machines Nos. 2 and 4 goes to the next machine in each instance; that is, from machine No. 3 it goes to No. 4, and from No. 4 to No. 5.

The products of Nos. 1, 0, 00 and 000 of the grader, after being aspirated, are spouted together, and are then sent to the purifiers of the aspirator pattern, as previously described, when they are submitted to a second sieve action and graded again by the same numbers. This is done on machine No. 5. This operation is repeated on machine No. 6. The tail of each of these machines would go to the tailings. The impurities drawn out from the middlings on each aspirator would also go

to the tailings. The product of machine No. 6 is divided into two grades of middlings for sizing, grade No. 1 being composed of middlings Nos. 00 and 000, and grade No. 2 of middlings from Nos. 1 and 0. The sizing commences with grade No. 1, which is sized down to the next grade as represented by No. 0. The product of No. 3 cloth of reel *A* goes to reel *D*. The desirable portion of the product of No. 0 goes to a single aspirator, shown at the tail of reel *A*. The undesirable portion of the product of No. 0 goes with the tail of that reel to the tailings, the separation being made by slides under the upper conveyor. Pushing in slides under the upper conveyor is destined to direct the carrying of such material as is included by that slide, toward and with the tail of that reel.

The product of No. 0, after being aspirated, goes with grade No. 3. The impurities drawn therefrom in aspirating go to the tailings. The product of grade No. 2 is sized down to meet the next grade, as represented by No. 2 cloth, and as indicated by the tail number of reel *B*. The general direction of the separations of reel *B* are the same as previously indicated. The product of No. 3 goes to reel *D* as before; the tail and undesirable portion of the product of No. 2 goes to the tailings, and the desirable portion of the stock of this number goes through the aspirator and to grade No. 3. Grade 3 is handled substantially in the same way, excepting that the product of the aspirator goes to reel *D* instead of to another set of rolls. The setting of the various rolls is indicated by the tail numbers of the scalping reels which follow such rolls. The first grade is sized down to grade No. 2, which is represented by No. 0, and the second grade to grade No. 3, which is represented by No. 2, and the third grade to grade No. 4, which is represented by No. 4. The product of the heads of the first two reels under the rolls, and the entire product of the third, is sent to reels *D* and *E*, as indicated. This means that the entire product of clean stock of the sizings rolls goes to these reels, where they are dusted, and the better portion, which tails over a No 6 cloth, is sent to the purifiers 7 and 8. The product of the No. 6 cloth from reel *E* is taken up as purified middlings and sent to the bin. The tail of reel *D* and the undesirable portion of the No. 2 cloth at the tail goes to the tailings. The middlings which go to purifier No. 7 are included with those which will tail over a No. 6 and pass through a No. 3 cloth, the tail number on reel *D* and of purifier No. 7 being 2, though the stock which goes to such numbers is that which has passed

through a No. 3. Such numbers are so disposed that they will prevent the liability of waste of tailings over cloth when heavily loaded. The tails of purifiers 7 and 8 go to the tailings. The product of No. 8 goes to grade No. 4 of purified middlings, being uniform in size with that grade. Thus it will be seen that all the middlings are sized down to an approximately uniform grade.

CHAPTER LXV.

THE FINAL REDUCTION OF MIDDLINGS—MILLSTONE METHODS OF REDUCTION IN HUNGARIAN MILLS—CLOTHING OF REELS FOR MIDDLINGS OF VARYING SIZE PREVIOUS TO REDUCTION—CLOTHING REELS FOR MIDDLINGS FROM HARD AND SOFT WHEAT—METHODS OF CLOTHING REELS FOR MIDDLINGS REDUCED BY BUHRS—METHOD OF CLOTHING REELS FOR MIDDLINGS REDUCED BY ROLLS—A COMBINATION METHOD OF REDUCTION AND SEPARATION WHEREIN ROLLS AND MILLSTONES ARE USED.

Having described the general principles of the purification of middlings, as understood by the writer, a system which contemplates their gradual reduction and gradual and intermediate purification, it may be in order to say something about the final reduction of such middlings into flour. In the more complete diagram as given, all the middlings were reduced gradually, and after each reduction were purified until, in the course of such reduction, all could be passed through a No. 7 cloth. Then they were regarded as purified; that is, purified as far as possible by mechanical means which are now at hand. In any event, they were regarded as middlings which were in a condition for final reduction into flour.

In Hungarian mills where the foregoing system of purification is in general use, the middlings, after they reach this stage of the process, are reduced gradually by buhrs. They are touched very lightly with smooth buhrs through three successive reductions, from each of which reductions the highest grade of patent flour is taken off. They are not crushed or pulverized, but are granulated. The grinding is high relatively. Thus whatever impurities there may be remaining in the middlings are not liable to be pulverized or disintegrated by the stones. The middlings particles are reduced while the impure particles may be tailed off from the reels. Grinding of this kind—that is, high grinding with smooth surfaces, is not the barbarous process which is usually assigned to the process of millstone reduction of middlings. It is barbarous when the grinding is close—when the buhrs are out of balance or face.

As the previous chapters on purification have had to do more with the general principles and the development of those principles, we will not now consider the reduction of middlings in any other sense than that of principle. It will not be considered with reference to that of special sized mills, but will be adapted to mills of various capacities during some of the later chapters.

In the diagrams which follow as illustrative of the means of reduction and separation which may be used in connection with the methods illustrated in the previous chapters, it may be noticed that on all the reels there are scalping cloths, and it is well to say here that these numbers cannot be fixed arbitrarily. They depend upon the system or method which may be carried out. If the middlings be reduced so that all will pass through a No. 7 cloth, some of the tail scalpers may be fine; or if the wheat of which the middlings is made be very hard and brittle, in that case they may be fine also. Again, if the middlings are very soft, some of the scalpers should be made coarser. This explanation is given to indicate that there can be no arbitrary rules in that matter, and that conditions which vary require that the methods should vary as well. Take as an illustration. Fig. 1. If all the middlings had only been reduced so that the coarsest would pass through a No. 4 cloth, and if such middlings were made out of soft wheat, it might be found that the No. 8 cloth would be too fine; or that the grinding would have to be lower than would be desirable in order to prevent waste, the method of middlings reduction, in this instance, being by millstones. Again, if the middlings had been reduced so they would all pass through a No. 6 or 7 cloth previous to final reduction, it would be right and proper, if the middlings were quite hard, to use if possible a finer number for the first tail scalping cloth, or, if not that, to run a little more of the product of the No. 8 with the tailings, which would be entirely possible with the conveyor as arranged.

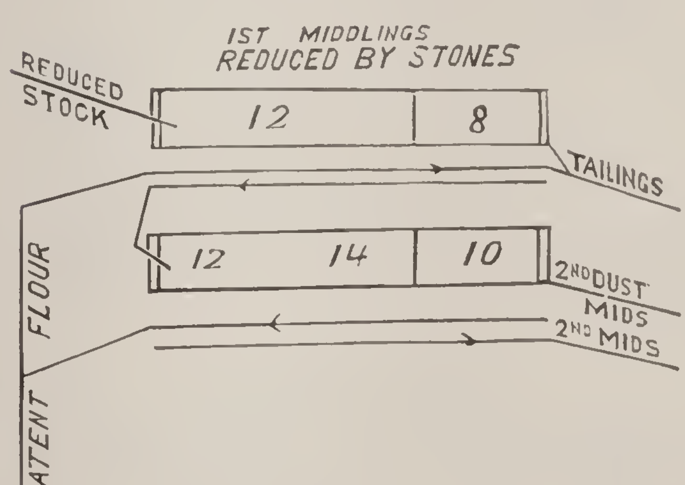


Fig. 1.

Figs. 1 and 2 illustrate a method of clothing reels for the reduction of purified middlings by buhrs. In this instance flour is taken on the first reel. If the mill were large enough to justify it, it would be well to use

a scalper with the same number of cloth on it as shown for the tails of the first reels, which is No. 8. Fine middlings which have been reduced by the millstones do not contain such a large proportion of sharp material as to prevent them from flouring nicely immediately subsequent to reduction or to any scalping operation, though if it is entirely convenient, the scalping previous to the flour separations would be somewhat of a help. The conveyor under the scalping cloth of this first reel is shown as running toward the tail. By closing slides from the tail forward under this conveyor it is possible to send any proportion of the tail product of the No. 8 which may be desirable, to the tailings. The amount of such stock can be determined best by examining the quality of the material which would drop into the bottom conveyor, or the conveyor which carries stock to the bottom of the next reel. It is one of the nice things about the arrangements for setting conveyors side by side, that the stock may be conveniently examined as it comes from the slide, and in that manner it can be determined to a nicety just what to do with the product of each fractional part of the reel. There will be times when a part of this No. 8 product of the first reel, as shown in Fig. 1, would be quite red, and should then properly be sent to the tailings. Aside from the fact that this stock is sent to the tailings, the advantage to be gained is the proportion of sharp material before the stock goes to the next reel.

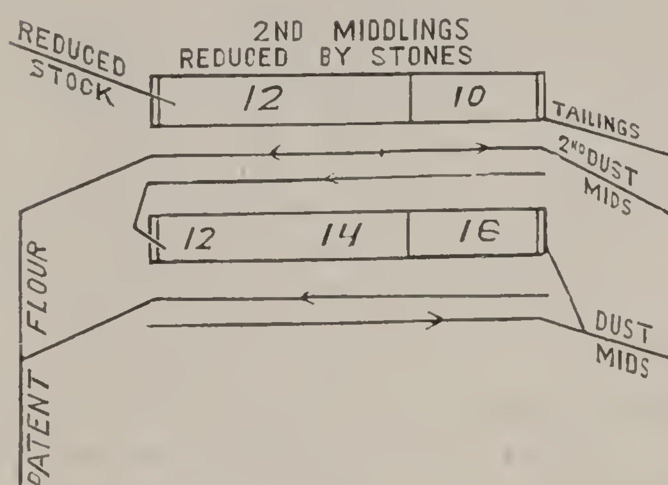


Fig. 2.

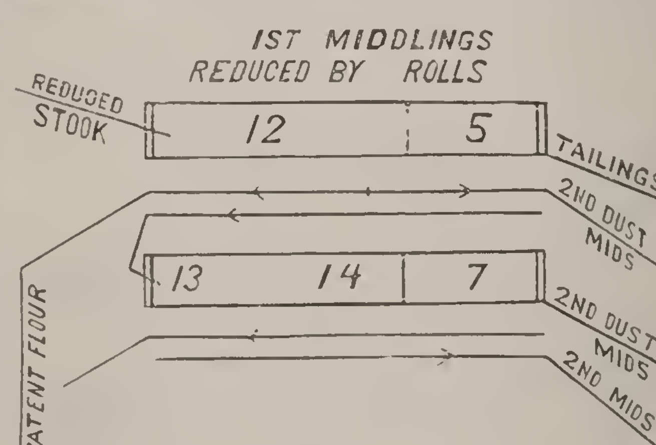


Fig. 3.

The product of the No. 9 on the second reel is second middlings, together with the cut-off from the No. 14 cloth. The tail of the No. 9 cloth is second dust middlings. The quality of this second dust middlings can be regulated by the quality of the material sent to the tailings from the upper conveyor under the tail cloth of that reel. It will be seen that in this instance the product of second middlings are such

as will pass through a No. 9 cloth. . Middlings of this grade through this cloth can only be made by millstones under the circumstances above mentioned. Fr m rolls, the second middlings are always coarser. The next, which is Fig. 2, shows the reduction of the second middlings from the previous reduction, and, as shown, is by millstones. There is only one scalping cloth on this sys'em, the tail of which goes to the tailings, and a certain small proportion of this tail cloth to the dust middlings. The proportion of such material taken out by this scalper and sent in the direction indicated, wi l be entirely owing to the purity of the middlings previous to their first reduction by millstones and the care of the bolting arrangements of such reduced stock. Nos. 12, 14 and 16 cloth are shown on the bottom reel. The use of No 16 cloth is justified here from the fact that the stock would probably be thin and the material which goes through it will be quite as sharp as that which went through the No. 14 on the same reel. The cut-off and tail from this reel is first dust middlings, and attention is called again to the fact that the quality of these dust middlings is entirely owing to the amount of poor material which is allowed to be taken off by the tail conveyor under the scalper. The attention to these scalping cloths and the conveyors under them is so important, and exercises so great an influence over the quality of the product of the following reels, that frequent attention has been called to that fact and will be repeated in the description of nearly every figure which is to be given in the subsequent chapters. Figs. 3 and 4 indicate a method for the reduction of middlings by rolls. The tail numbers, as said before, are to be

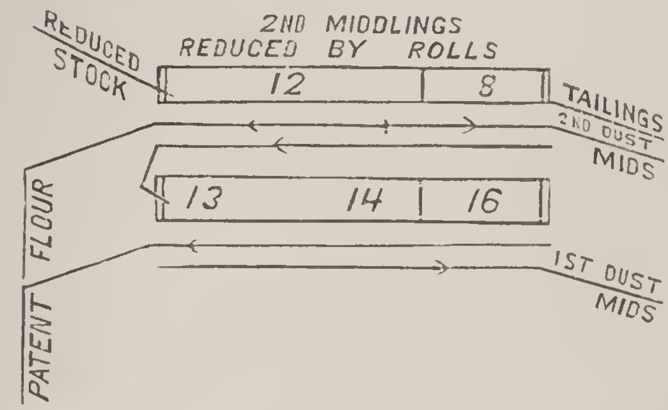


Fig. 4.

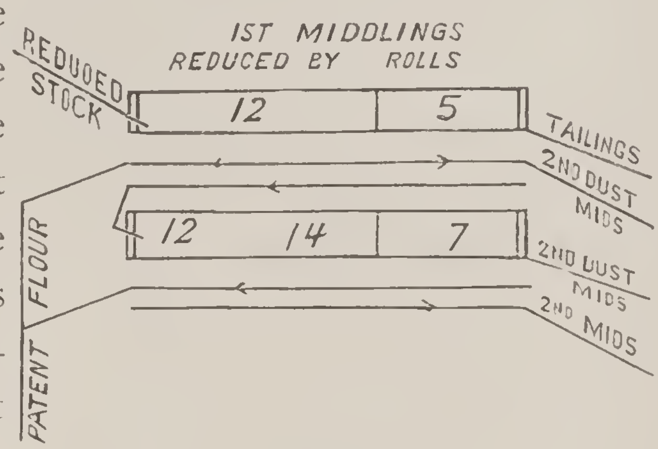


Fig. 5.

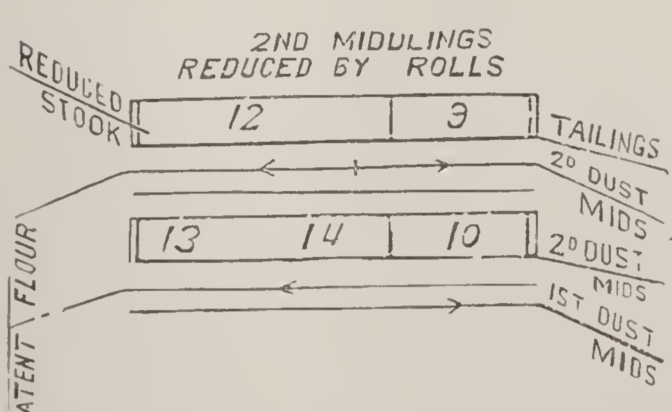


Fig. 6.

determined entirely by the size of the middlings going to these rolls. It should be remembered that all the scalping numbers on flour reels should be kept as fine as possible, so that they tail over enough of the impure stock, but not too much. The principles involved in bolting the stock which has been reduced by the rolls are the same as those described in the bolting of the stock by millstones. The second middlings from the reduction by rolls are somewhat coarser than those made by the millstones, the former having passed through No. 7 cloth and the latter through No. 9. Then again, the dust middlings from the second middlings from rolls are coarser than those from the millstones. No. 8 as compared with No. 9 illustrates the difference.

Figs. 5 and 6 show a compromise between the reduction by rolls and that by millstones. In this case the first middlings are reduced by rolls and the second middlings by buhrs. This is an especially good system for small mills where it is not possible to gradually reduce and gradually purify the middlings as far as we would wish. It will be seen that the dust middlings are of the same size where they leave the last reel from Fig. 6 as they were from Fig. 2, where both reductions of the middlings were by millstones. It may be noticed that the questionable stock of the better grade which comes from the roller reduction is sent to the second dust middlings.

CHAPTER XLVI.

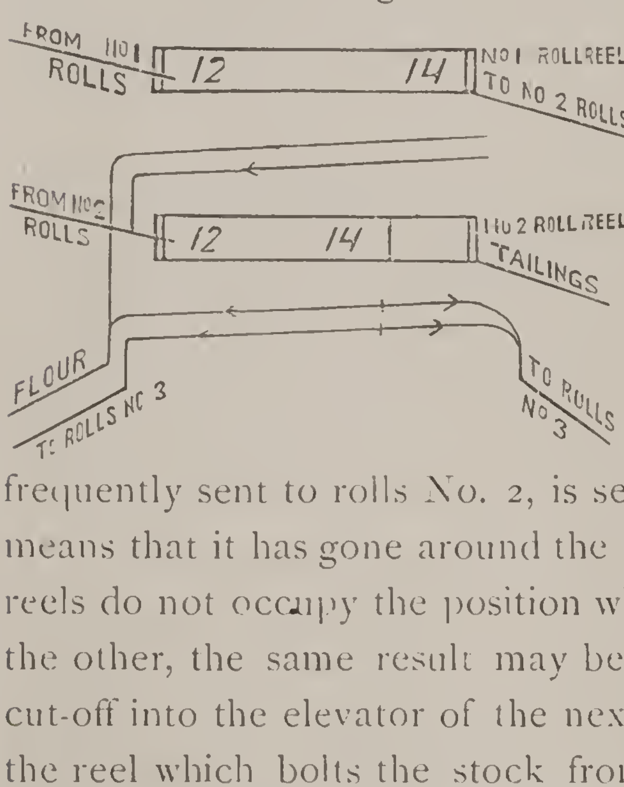
SMOOTH ROLLS AND THEIR PRACTICAL OPERATION—FEEDING OF SOFT STOCK—ARRANGEMENT FOR KEEPING SOFT STOCK OFF THE ROLLS—THE TENSION SPRINGS—SPEED OF FEED ROLLS—RUNNING OF STOCK OVER THE ENDS OF ROLLS—SCRAPERS—ROLLS OUT OF LEVEL.

Our "Journey Through the Mill" has brought us past the purification of the middlings. We have said so much in a general way about the use of smooth rolls, the theory of their working and all, that it will not be out of place to stop here to consider, in a more practical way, some of the features of smooth roll operations.

The writer once received a letter asking for information in regard to the best mechanical device for an attachment to feed rolls which would aid in feeding soft stock. The writer of the letter said that he had always had trouble with the material going to some of the smooth rolls, and had tried a great many attachments, among which were vibrators, rakes, etc. It is not necessary to make any changes in the feed rolls as ordinarily constructed. The whole trouble may be obviated in the bolting apparatus. It is common custom to run the flour cut-off and the tail of the reel to the next set of rolls. As far as the tail is concerned, this is all right. Flour cut-offs have no business on a smooth roll. Having been reduced to flour once—having passed through a flour cloth—farther reduction is not necessary. If any benefit could be realized by reducing this stock by itself, it causes trouble enough and harm enough because of the irregularity of the feed when it is mixed with other material, to more than overbalance the anticipated benefits. Furthermore, it is not good milling practice to try to reduce coarse and fine stock on the same rolls. Not alone because it will not feed regularly, but because it can not be uniformly reduced, even if it could be as regularly fed. As to the importance of such a feed, it may be said that no set of rol's can possibly do regular work, and no reel or set of reels can make regular flour, when the rolls do not do regular, even grinding. It is essential, in order to reach the best results, that there be an even, thin stream of stock, and that its uniformity be preserved from one end to the other.

There may be a slight increase or decrease in volume from time to time, and by correspondingly changing the set of the rolls, uniformity of product may be preserved; but let it begin to come through in lumps and in an irregular way, and the flour from the reel which bolts that stock is sure to drop down. Nearly every one knows this, and it is only written as a reiteration of a recognized but often neglected principle. It is frequently the things which we know very well that we so sadly neglect. This same thing, i. e., the regularity of roller feeds, is a thing which is sadly neglected by millers who are fully aware of the attending evils.

To return to the original subject under consideration: It was said that the whole trouble of feeding soft stock on rolls might be obviated on a bolting apparatus, and that flour cut-offs had no business on smooth rolls. Herewith is given a sketch which will illustrate a method of switching the flour cut-offs around the rolls rather than into the roll hopper of the next roller reduction. Take the first reel, for instance. The tail is clothed with No. 14 cloth, the stock passing over which goes to rolls No. 2. The cut-off from roll reel No. 1, or the stock which is so frequently sent to rolls No. 2, is sent to roll reel No. 2. This virtually means that it has gone around the roll, rather than through it, and where reels do not occupy the position which is here shown, that is, one under the other, the same result may be accomplished by spouting the flour cut-off into the elevator of the next roller reduction. It then goes into the reel which bolts the stock from that reduction. With the plan as here shown, there is always dusted stock sent to the next roller reduction, and hence stock which feeds readily and without coaxing. Where this coaxing is necessary, it would take one man for every machine, and, as no miller could think of doing anything so absurd, he would do the other absurd thing and have an irregular feed; and if it was carried far enough in its irregularity to influence the general grade of the product of the mill, which, by the way, is very readily done, there would be an irregular flour and an irregular market therefor.



In a mill where the plant is large enough, it might be well to take some of the stock which represents the coarser particles of the flour cut-off and reduce it by itself. Where the mill is not large enough to

justify this being done, it is well to do the next best thing possible—come as near the accurate grading as possible.

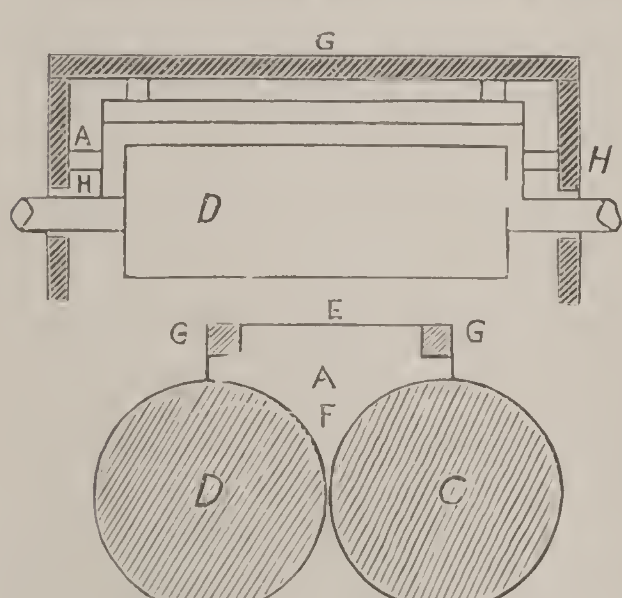
There is a point in the reduction of soft stocks, more especially when soft wheat is used, where roller reduction does not appear to have much effect upon it. It is that point where the material begins to feel feathery and flat. A centrifugal reel will help this out to a considerable extent, but there is a point beyond which even this cannot go. It is then that we use the millstone, and the work is done. One of the many causes which lead to this condition of things is grinding too close in the first reductions on smooth rolls. Another point is in trying to grind too much on all of them, and, as said before, one of the causes is in the natural condition of the wheat. There appears to be a point, in some instances, beyond which a smooth roll will not go.

The tension spring on rolls is neglected in many mills, and often when not neglected it is wrongly used. There is a disposition on the part of many to set them up very tight. A miller once told the writer that the objection he had to a certain roller mill was that the hand wheel of the tension spring was not large enough. It was suggested that he make up the deficiency by the use of a 14-inch monkey wrench. He had a feed about a quarter of an inch thick running to his rolls, the rolls being set up as tight as he could get them, and the belts as tight as possible. All this was positively wrong. The tension spring should be set up as lightly as possible to do the work, and a smooth roll should not have so much work to do but that it can do it without flaking. The corrugated rolls should have no more to do than they will do without indication of overwork, such as a mushy appearance of the stock, flat middlings, large proportion of flour and badly lacerated bran. The tension spring should be adjusted to suit the work done by every machine.

Another thing which will bear attention is the speed of the feed rolls. Often it will be found that while the stream of stock going to the rolls is heavy and sluggish, it may be made thin and free in its movement by increasing the speed of the feed rolls. It is often seen where improvements may be made in this respect. It is not generally understood that a material change may often be made in this way. There is nothing so important in the reduction of the material in the mill as the proper feeding of the stock for the rolls, and at the same time it is one of the things which is very seriously neglected. The writer once heard a very clever illustration in regard to the effects of overfeeding the bran rolls. A

young man said that if one ran three thicknesses of paper through the bran rolls, the outer paper would be most seriously affected thereby, and that the middle one would be protected. This illustration was intended to convey the idea that where a heavy feed of stock was run to the rolls, there were certain particles that would not be affected as desired by their operation.

In examining the tail of the reels which handle the stock from smooth rolls, one frequently finds stock which does not appear to have passed through the reel; on the contrary, it is as large and sharp as it was when it went into the hopper. Of course, this may occur because of the imperfect action of the scrapers. This trouble is readily recognized, and is not for consideration here. It is possible for stock to pass over the feed rolls to the rolls themselves and yet not between them or through them, and still pass down into the lower hopper and from thence to the reel and over the tail without having been affected in the least by the rolls—not having passed between them, but rather, as it frequently does, over the ends. This is not stock which falls near the ends of the rolls, but it will run out from a distance of several inches from each end. Roll builders frequently furnish sheet metal arrangements to fit down between the rolls for the purpose of preventing this, but they soon get bent and out of shape and are worse than useless, because they are depended upon to do something which they do not. They invite confidence and soon betray it.



The best thing to use for this purpose is ⅞-inch hickory cut in the form indicated by *A*, and placed as *A* between the rolls *C* and *D*. It should rest on the roll half an inch from each end. The grain of the wood should run in the direction of *E* to *F*. Thus the ends will not be broken off as they would with the grain running crosswise. These pieces *A* should be set one at each end of the roll and connected by the pieces *G*. The top of the piece *A*, at which point the pieces *G* are let into it, should extend high enough so as to fit under the wood casing of the roll. If the casing touches this contrivance lightly, the fit between the rolls will always be a close one. The pieces *H* extend out from *A*

so as to prevent the latter from moving sidewise. It should be just long enough to nearly approach the sides of the wood roll casing.

We would suggest that our miller friends look over their smooth rolls with a view of determining whether they are losing anything in the manner previously mentioned. It may be best determined by an examination at the extreme ends of the roll—beyond the point where one usually expects to find mill stock.

The scrapers play a very important part as contributing to the successful operation of smooth rolls. This fact is noticed to such an extent by at least one firm that they are putting two scrapers on each roll. The failure of a scraper to do its work properly has the same effect on the quality of the work as does improper feeding. A great deal of time and trouble may be saved in starting new mills by carefully setting the scrapers. It is best that they should be taken out and carefully dressed with a file and then set back, after which they should be adjusted so nicely that they will hold a piece of paper tight to the rolls throughout their entire length. If this work is done conscien iously, there will be little or no trouble from this source, and there will be a great deal less poor flour made at the outset than is common. Smooth rolls cannot do good work unless the scrapers do their work completely and as intended.

Rolls being out of level causes trouble with the flour as well as with the final finish. By being out of level is meant that they are not in the same horizontal plane. This is very injurious to the rolls themselves, as the point of contact is at a smaller point or for only a small portion of the rolls, and wears them unevenly and gives a concave surface to each. The grinding cannot be in any degree satisfactory or complete, and, as implied before, the finish of the mill cannot but be extravagant and wasteful. A very good way to do, especially in starting up a new mill, is to first level the rolls after the belts are put on, and then, after they have been run awhile empty, and immediately before putting on feed, to go over them again, and after they have been run a week or thereabouts, to go over them once more, and regularly thereafter about once in two weeks. A miller will notice each time that some of the rolls are out of level. This fact should prompt careful attention and an estimate of the attending evils.

CHAPTER XLVII.

TAILINGS—THE REDUCTION OF TAILINGS—ASPIRATING TAILINGS—GRADING OF TAILINGS.

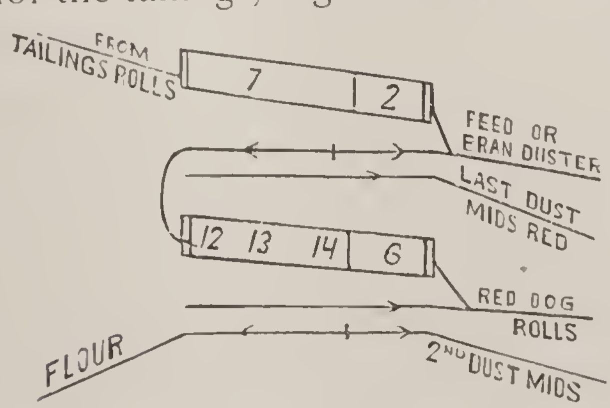
Having in mind all that has been said about middlings and the reduction of the various stocks by rolls, it is a natural thing to take up the tailings.

This word tailings has a wide, mixed and uncertain meaning in milling. The hopper of the tailings rolls is a kind of a mill cesspool in many instances. It has everything run into it which has no other regular assignment. With this same stock is frequently sent the cut-off from the last machine. Now there is with this material the best middlings in the mill, and, at the same time, the worst. In the reduction of the mass by smooth rolls, the flour product is seriously contaminated If there is nothing better to do with a particular kind of material, or if one is at a loss to know what to do, more often than otherwise he sends this stock to the tailings rolls. In small mills this sort of thing is demanded; nothing else can be done. But there are other mills where this is done, but without the necessity or mitigating circumstances. Where it is possible, where the mill is large enough for two sets of tailings rolls, the stock should be graded so that one set would get the fine tailings and the other the coarse. It is not imperative in this case that there should be separate bolting arrangements for each grade of material. This separation on the rolls is made so that the grinding can be more perfectly done. It is well known that the mixture of coarse and fine stocks in reduction is fatal to the best work. In small mills, where separation is out of the question, the stock has to be ground together unless it is divided and ground at different times, which is not an accepted method. At times the coarse and fine stock is spouted into the hopper through different spouts, this being done as a matter of convenience in spouting, and not with any particular method in mind. In this way, the fine part of the stock would go in at one end of the roll and the coarse at the other. This not only makes bad grinding, but is also very uncertain. and generally very unsatisfactory. Where coarse and fine

tailings have to be reduced together, it would be well to mix the stock. The necessity for even grading in the reduction of stocks may be said to be of still greater importance, as applied to the smooth roll reductions, than to the first break by corrugated rolls. The reason for this cannot be said to be in the rolls themselves, but rather in the character of the stock. Taking the tailings stock as an instance, it is easy to see that there is a greater difference, more of an unevenness in the size of the various pieces, than there is in the wheat of the first break stock; and hence more of a reason for grading in order to secure the full benefits of a reduction.

Where it is possible to divide the stock, as suggested, on two sets of rolls, and then run into the same bolting apparatus, the flour will be much better than if reduced on a single set of rolls. A more conspicuous reason for this division is the quality of the finish; but because of its being conspicuous is no reason for its being more important than the other. The tailings rolls, it should be remembered, are intended to perform the office of purification, as well as of reduction into flour, or the finishing of a part of the stock for feed. This being so, it is important that each granule should be subjected to the same purifying and discriminating influence. Each granule should be touched by the rolls in an approximately uniform manner; hence the division of the coarse and fine stocks. A uniform action is necessary for a uniform result. With particular reference to the quality of the flour, it is necessary that no unreduced particles should go into the reel, or, rather, none of the particles which have not been influenced by the rolls. The reasons for this, it will be remembered, were given in a previous chapter.

The accompanying sketch illustrates one method of clothing the reels for the tailings, together with the distribution of the new grades of stock,



brought about by its reduction. The stock is scalped on Nos. 7 and 2 cloth, the product of the No. 7 going into the flour reel below, and the undesirable portion at or near the tail of No. 7, and that which goes through the No. 2, to the last reduction of the dust middlings. It would be preferable if there were three such reductions, and this stock went in with the third; or, better yet, if the mill were large enough to justify it, to a second reduction of the

tailings, in which event the first reduction need not be so severe. The second reel in the diagram given is clothed with Nos. 12, 13 and 14, and the tail with No. 6 cloth. It might have been said that the tail of the first reel goes to the bran duster. The tail of the second reel goes to the red-dog rolls. If it is too rich, all that remains to be done is to open slides near the tail of the No. 7 cloth above, so as to throw more stock into the bottom conveyor under the first reel. This would reduce the proportion of sharp material in the bottom reel, make the flour better, and the tail lighter and poorer.

In the tailings is a large amount of soft, fluffy stock, which comes from the aspirators and the tails of the machines, together with other material which gives it place as tailings. A good thing to do with all this stock previous to reduction would be to run the entire body of the material over a grader, and then through aspirators to take this fluffy material out and put it into the feed. This could be readily done in such a way as to greatly improve the quality of the tailings, and at the same time not run anything into the feed which does not belong there. Aspirators can be made to be very sensitive, and to make very nice discriminations in the separations. The grading of the tailings would be done for the purpose of being able to aspirate the stock economically. In this way the currents of air could be adjusted according to the specific gravity of the contained impurities.

One of the bad things which is frequently seen in the operation of a mill is the sending of tailings from the coarse middlings purifiers to rolls without aspirating. It is one of the simplest things imaginable to aspirate this stock and almost entirely remove this fibrous and damaging material. A prominent millbuilder said that one reason why this stock was not more universally aspirated, or purified, which in effect means the same thing, was that to the eye the middlings did not look much better after being aspirated than before, this being accounted for by the fact that there are large particles of middlings with adhering portions of bran. Thus the middlings could not look white. In sizing middlings this bran is not materially disturbed, while the flour and middlings portion is broken and separated therefrom. There have been published in connection with this work descriptions of aspirators which are in every way suitable for this purpose. They are among the simplest, most inexpensive and most efficient machines which can be placed in the mill. If the coarse middlings are aspirated before they go to the purifiers.

coarse middlings purifiers themselves will be so materially aided in their work as to reduce the number of machines needed to purify the middlings of the mill. These aspirators may be set in any place, and connected with a suction fan conveniently located. A fan of proper size may be made to answer for a large number of aspirators. Another use to which these machines may be put is in the aspiration of stock which goes to the tailings rolls. The use of this device will lead to the improvement of the work of every mill in which they are placed. It is a device which has been neglected. In it there is the way open for simple and inexpensive improvement.

CHAPTER XLVIII.

LOW GRADE STOCK—GRADING OF LOW GRADE STOCK—CENTRIFUGAL REELS FOR HANDLING LOW GRADE—THE BRAN DUSTER—RELATION OF LOW GRADE REDUCTIONS TO THE YIELD—USE OF SCALPING REELS WITH REFERENCE TO THE REDUCTION OF YIELD.

The methods of handling low grade stock at the tail end of the mill have received very little attention. Most that has been said has been in regard to the higher grades. Percentages of low grade flour and other general features have been talked about, but the details have not been looked into. In following out a diagram, or in doing the same thing in a more practical way—following out the run of the stuff in a mill—we see material of varying qualities going to the red-dog bin. It may all be of low grade color and character, but it will be in different forms in varying stages of completeness in its reduction, and in different sizes as to the particles. We all know that uniformity is desirable in any reduction of any grade of stock. Different qualities may invite different manipulation. Where there is this difference, anything which is exactly right for one grade is exactly wrong for another. There can no more be compromise and still exact justice to all alike in this instance than there can be in other things. A compromise always suggests the idea of injustice, and frequently to all alike. It means merely the best thing which can be done under the circumstances. But when we come to the point of suggesting what is right and proper in the case of the treatment of the red-dog stock, we run against a common obstacle, which is the size of the plant, and as by far the larger proportion of mills are so arranged as to be influenced by the limitation here implied, it remains to give this subject such consideration as this condition will warrant.

On the above basis it will be recommended that the miller who in the future buys rolls for the purpose of reducing his red-dog, should, in the case of his having a small mill, buy two small pairs instead of one long pair. In this way he can get the red-dog material into two grades—coarse and fine—and thus do justice in the reduction to each kind of material. For the purpose of realizing on this principle a little further,

it would be a good thing to scalp the coarse grade of stock by itself, before sending it with the general body of reduced red-dog material to be scalped and bolted finally. This may be done on a common form of centrifugal reel, a cheap variety of which is made by having a stationary reel with revolving wings set spirally. If it is possible for economical reasons, this reel might be set under the roll and the product could be run into the common red-dog chop elevator and the tail presumably into an elevator which leads to the bran duster. It is not always possible to arrange this thing mechanically. Such a method of aspiration makes the general bulk of reduced red-dog material all of the same character, and hence it is in a better condition to be treated satisfactorily and with the assurance that there are no limited conditions as to the excellence of the work in the character of the stock itself. From the elevator it would be well to run this stock to a centrifugal reel clothed with Nos. 8 and 9 cloth, a product of which is run into another centrifugal reel clothed with proper flour numbers--say Nos. 12 and 14. There will be one grade of feed from the tail of the upper reel and another one from the tail of the lower one. If this is the last reduction in a mill, as it is fair to presume that it is, this can not be anything else than feed, and can be only so treated. As has been said before, if this stock is too rich for feed, further milling is suggested, which can only be done by additions to the plant. This will pay as long as the flour produced exceeds the value of the feed, taking into consideration the question of the additional cost of manufacture by such methods.

One thing to do with the tails of the reels mentioned, is to run them through a vigorous agitator or bran duster of some kind and bolt out the product on a centrifugal reel. This is a make-shift, however. One very good reason for using centrifugal reels at this stage of the milling is that a large proportion of the material which goes to make up the red-dog stuff in its legitimate state of thinness, in quality is soft and flaky, or feathery, and the principle of the centrifugal reel is such that it will make the most of these unfavorable conditions. Furthermore, the centrifugal reel can separate or bolt this material when it is softer, than can any other reel. As has been said before, the softer one can bolt any material, consistent with economy, the whiter, cleaner flour will he get. In lieu of the lack of complete methods for the reduction of the red-dog, and taking into consideration the disproportionate size of the plant

in this part of the mill which would be required to make it complete, and again, considering the cost of manufacturing this low grade material with reference to the final price of the product, it may be said to be allowable or possibly desirable to use more vigorous means in its reduction and separation than would be desirable or profitable with other higher and more valuable grades of stock. Hence the mention of the use of the bran duster or other vigorous disintegrators for the tails of the red dog reels. The quantity of such stock is not large, and the proportion of flour therein is small, so that when we consider that the previous milling and grinding have been well done, there are not many cases where the rolls are large enough to justify continued handling.

The treatment of the material from the bran duster has been here outlined. Where the course before mentioned with reference to the scalping of the bran from the last reduction of the wheat is carried out, there is little benefit to be gained by running it through a duster; yet it is a safe thing to do. One thing which is frequently neglected is to run the tail of the red-dog through such a machine. This is more important than the bran, and, where both are not possible, it would be well to let the latter go without such an operation and choose the former for dusting. The product thereof should be bolted out by a centrifugal. The proportion of stock to the amount of flour realized is larger in red-dog feed than is any other stock in the mill.

The low grade end of a mill is often and carelessly regarded as being the only place to which one must look in order to get a good yield. It is said: "We must clean our feed, and we do it with this low grade machinery." The mistake in this thing is that it is a too narrow view. It should be broad enough to cover the whole mill. A good yield can not be made without good finishing machinery, but if a sacrifice has to be made at either end of the mill, it should be done here. As a matter of business, such a sacrifice should not be made in any case. If the capacity of the mill is such that the owner cannot command the means to finish up reasonably well, ordinary prudence would suggest that he cut down the grinding capacity.

We see mills operating under varying conditions. We see those that are thoroughly well equipped, and again others whose means for making good and cheap flour are meagre indeed. In the natural movement of things it will be found that the latter mills will have to step out or step up—they will be forced out of business, or will be forced to add to their

equipment. Time was when there were only a few mills which made a very high grade of flour; now there are many. There are very few mills now which are making very cheap flour. As time moves on there will be many more. The mills will come more closely together on the question of cost, as they have on the question of quality. This element of cheapness will be a more forcible one than the original one of quality, because, when the latter was the great point, the demand for flour was much greater than it is now. Everything which was made could be sold at a fair price. Now the producers are in the ascendency, and the buyers of flour can demand, in a strong way, cheap goods. Thus competition will be to make the cheapest flour, and, as the milling capacity is excessive, those who can make it cheapest can run their mills, and those who cannot must stand idle.

This condition of things has a bearing on the mechanics and upon the system of milling. It demands that all that pertains to the usual operations be considered as to the quality of the work and as imperatively as to its cost. A great deal too much dependence is put upon the low grade machinery, in order to bring the yield down. The whole mill—every piece of machinery in it—has to do with the yield. We have to begin with the cleaning of the wheat, and then keep in mind the reductions, one by one, remembering that any stock which is carried over from one reduction to the next adds just that much to the work of all machinery which follows. If any of that stock which is carried over ought to have been taken out rather than reduced with other material with which it does not belong, it should be known that it will, in proportion to its amount and quality, affect the yield. For instance, say that the break scalper is too short, or that it is clothed too fine, or gets filled up in a way to influence its capacity, it is apparent that the flour or middlings which should have gone through the cloth will pass over to impede the action of the reduction machinery, and in the same degree ultimately affect the yield, and as well the quality of the flour. Take another case of the lighter or softer stocks. If flour which should have been taken out on the bolts be carried over to the smooth rolls, it is apparent that their feeding will be interfered with and that at the same time the stock will be increased in volume and made more difficult of reduction. This is a very common source of trouble, made necessary by the arrangement of the separations. Say that the coarse material fol-

lowing a reduction be not separated from it before beginning to take off flour in the flour reels, it will then be found that it is necessary to send quite a proportion of flour with the cut-offs or tails in order to prevent the regular flour product which goes to the packers from being specky. The accompanying sketch will illustrate this latter point. Say that a certain grade of stock be sent into the reel in Fig. 1. It will be found that, owing to the coarse material going directly into this flour reel, there will be a large volume of cut-off, in consequence of the flour being specky, and it will be so sharp that the flour will have to be reduced again. Very often this operation is repeated on the next reduction. Thus it will be noticed that only a comparatively small portion of the flour made at each reduction is sent to the packer, and stock which has been reduced to the fineness of flour is sent, because it contains objectionable stock, to the rolls to be reduced time after time. It is easily seen what effect this sort of thing will have on the yield.

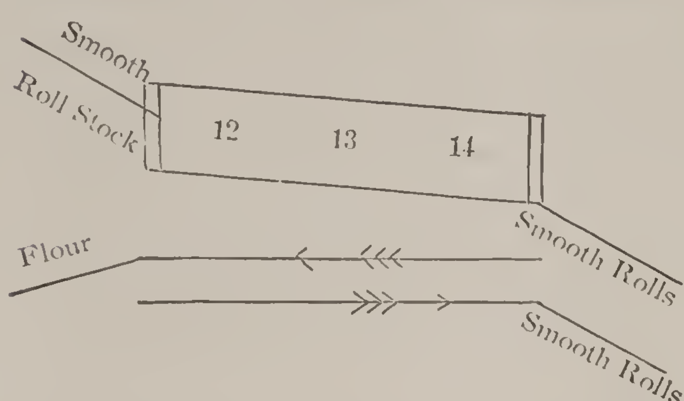


Fig. 1.

The arrangement shown by Fig. 2 provides for all this. It will be noticed that a scalper is provided and that it is clothed with No. 8 cloth, though this number would depend entirely upon the material going into the reel.

It is desirable that the stock which goes into the bottom reel should be as soft as possible to bolt without the use of wipers. In this way a larger proportion of coarse flour cloth can be used, and the flour will be finer and whiter than on the finer cloth in Fig. 1. There will be a very small proportion of cut-off, if the scalping number is selected properly. The tail from both reels in Fig. 2 will be thoroughly dusted. Thus the rolls will have to handle only such material as is best suited to them; that is, stock

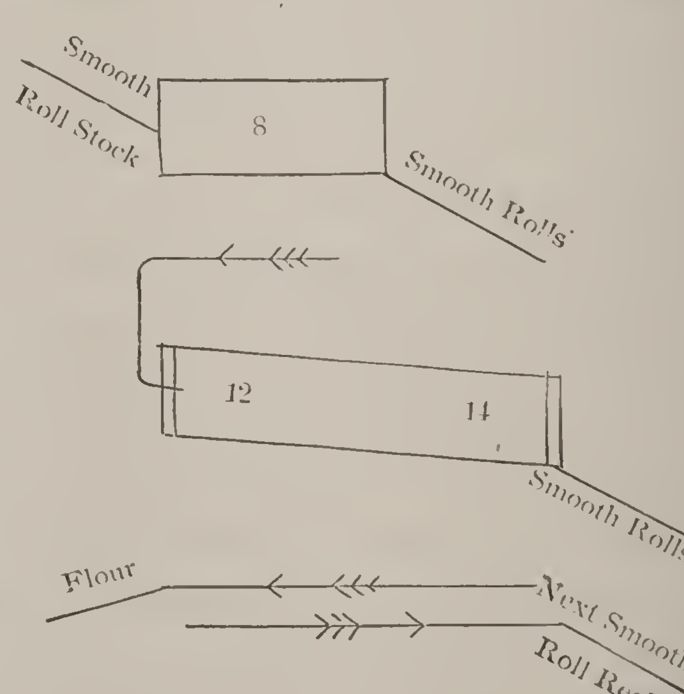


Fig. 2.

which is sharp and entirely free from flour. It will feed perfectly; and, again, the volume will be smaller than in the other instance. It takes a smaller number of rolls to accomplish a better result with this system. This same principle, in one form or another, can be carried entirely through the mill. It always furnishes dust stock to the rolls, the same as to the purifier.

CHAPTER XLIX.

SIZE OF MILLS—RELATION OF SIZE TO THE NUMBER OF REDUCTIONS—NUMBER OF REDUCTIONS FOR A SIX-BREAK MILL—CLASSIFICATION AND SUB-CLASSIFICATION OF REDUCTION AND SEPARATION.

As a general thing, any great difference in capacity between two mills implies a difference in the number of separations as well. In the smaller mills, only the greatest differences in the qualities of the various products are recognized in the classification of the material previous to its reduction or separation. In a larger mill, where the volume of stock is heavy and where the plant is not proportionately greater in cost than in a small mill, the classifications can be more numerous, as would naturally be suggested by the various differences in the stocks to be handled. It is obvious that as large a number of classifications cannot be made in a mill which is to make 100 barrels of flour as in one which makes 500, and there will be finer, closer differences recognized in the material in planning a 1,000-barrel mill than there would be in a 500-barrel mill. This statement is made looking at it from a commercial standpoint. Looking at it mechanically, it is altogether possible to make a 100-barrel mill which would be as complete and maintain as exact and fine differences in the number of separations, and, as would be suggested thereby, an equally large number of the various milling devices, and as complete an equipment generally as the best 1,000-barrel mill. But such a mill would be a commercial absurdity. In this mill there would be required almost as many purifiers, though smaller in size than in a larger one; quite as many reductions, though not as many rolls, and in many cases as many reels for handling a small volume of stock as would be required to handle a larger volume. For example, a certain number of separations may involve the use of two, three, or four reels, whether the volume of stock be large or small. In the small mill the reels could be smaller, but the cost would not be proportionately less. The difference that there would be in the cost of two such mills would be brought about, first, by the size of the various machines, and, as we all know, the difference in cost is not as their size; second, in the small mill there

would not be the necessity for the division of stock as to volume, as suggested by the capacity of the various machines on which this stock is to be handled. But a small mill of this kind could not be useful in a business way. It would bear about the same relation to a business undertaking that a working model does to the machine it is intended to illustrate. The small mills embody the general principles of milling as carried on in the larger mills. Where there are a very large number of classifications in the latter, with only minute differences as a distinction, in the small mills a number of these classifications are lumped—handled together—and thus the more elaborate system is simplified.

In a former chapter another condition of things in connection with these smaller mills was mentioned. In speaking of the higher quality of low grade flour which has been coming into market, it was suggested that it might be the result of incomplete roller milling; that is, unfinished milling. There is one end of the mill left out. In the desire for cheap mills and at the same time roller mills, something has to be omitted, and it is the tail end of the mill; and instead of making low grade flour, it is thrown into the feed pile. But such deficiencies are easily remedied by the addition of a few more reductions and the attending separating machinery.

Continuing in the line of the above subject, it may be of interest to consider the smallest number of classifications possible in a roller mill with six breaks. In any mill there will be the flour and the feed. These may be called the results—the reductions and separations with these results in view, the method, which is the interesting point.

To commence with the breaks of the wheat. there are the low grade flours and fine stock from the first break. Then there is the middlings, which can be sent with the other middlings to be purified. The second, third, fourth and fifth breaks yield a product from their scalpers which can be united and run into a middlings scalping reel for the purpose of separating the middlings from the flour. Say this is done on a No. 9 cloth. In a 100-hundred barrel mill this separation could be made and the middlings graded on one reel, clothing two-thirds of the head with a No. 9 cloth, and the remaining third with, say, No. 3 or 4. What goes through the No. 3 or 4 will be fine middlings, and what tails over it, coarse. The product of the No. 9 would go to two reels below to have the flour taken out. Say the flour cloths were Nos. 12 and 14, there would then be an intermediate product between No. 9 and these

numbers to be cared for; they are called dust middlings. This is a fine grade of middlings which is not usually run to the purifiers. If this stock is rolled two or three times on smooth rolls and bolted the second or third time on a centrifugal reel, the tail of the last reduction can go to the red-dog. The middlings, after being purified, and the coarsest sized, say once, should be reduced twice, each reduction requiring about two reels. At the tail of each first reel of these two reductions would be a scalper. If these reductions were by millstones, No. 7 would be a good number for the first reduction scalping cloth and No. 9 for the second; or, if roller reductions were used, two numbers coarser on each. In case of millstone reduction this tail could probably go to the red-dog; or from roller reductions to the second reduction by smooth rolls of the dust middlings, which go through the No. 9 cloth of the middlings scalping reel previously mentioned. The cut-off and last tail of the second middlings flouring reel would go to the first reduction by smooth iron rolls of the last dust middlings from the No. 9 cloth above mentioned. The sixth reduction and red-dog now remain to be taken care of. Then there would be the tailings rolls and one reel to follow them. The tail of this reel could go to the red-dog.

The sixth reduction stock, having been scalped over No. 30 wire, the flour can be taken out on a single reel clothed with Nos. 12 and 14 cloth at the head and a short piece, say of No. 3 or 4, at the tail. The product of this latter cloth would go to the red-dog, and the tail to the fine feed or shorts. The tail of the sixth reduction scalper would be bran. The red-dog, we will say, is ground on a buhr, and the flour bolted out on a centrifugal reel. The tail of the reel goes to the fine feed or shorts above mentioned.

To recapitulate, it will be remembered that there were six reductions, with six scalpers. The product of these reductions was originally divided into three divisions, viz.: 1st, the product of the first reduction; 2d, that of the second, third, fourth and fifth; and 3d, the product of the sixth reduction.

Each of these divisions was for distinct handling, and of each of these divisions there were sub-divisions. Those of the first were: 1st, the low grade flour; 2d, the red-dog stock; 3d, the middlings.

The second division, or that of the four middle breaks, was sub-divided: 1st, into coarse middlings; 2d, into fine middlings; 3d, into flour; 4th, into finest or dust middlings.

The third division, or the product of the sixth reduction, was divided into: 1st, bran; 2d, low grade flour; 3d, red-dog stock; 4th, fine feed or shorts.

The coarse and fine middlings from the first and second general divisions are purified. In this process the divisions are as follows: 1st, purified middlings; 2d, tailings; 3d, dust room stock; 4th, middlings to be sized.

The product of the sizings rolls is divided into: 1st, flour; 2d, fine middlings to the middlings bin; 3d, coarse middlings to the purifiers; 4th, tailings.

The purified middlings would be concentrated, and their reduction by millstones would bring about another division: 1st, flour; 2d, middlings; 3d, tailings. The reduction of the second middlings by millstones would divide the stock into: 1st, flour; 2d, dust middlings stock; 3d, red-dog. The only difference that this reduction by rolls would make, would be that this material which is mentioned as red-dog stock would probably be sent to the dust middlings second reduction. The dust middlings first reduction would divide into: 1st, flour; 2d, second dust middlings; 3d, tailings. The second dust middlings would further divide into flour and red-dog.

The tailings rolls reduction would imply four divisions: 1st, flour; 2d, dust middlings; 3d, red-dog; 4th, fine feed.

The red-dog divisions would be: 1st, flour; 2d, fine feed or shorts. The general result of this would therefore be flour, bran and shorts; or, to speak more broadly, flour and feed.

The classifications and divisions noted at some length include all the separations made by the reels and purifiers. The classification, as it is made on the grinding floor, as the material passes to the reduction machinery, is as follows: 1st, the six reductions of the wheat; 2d, the reduction of the purified middlings; 3d, the reduction of the second purified middlings; 4th, the sizing of the coarse middlings; 5th, the reduction of the first dust middlings; 6th, the reduction of the second dust middlings; 7th, the reduction of the tailings; 8th, the reduction of the red-dog. If this were a roller mill, and presumably a small one, thirteen pairs of rolls would be required, or there would be thirteen divisions of stock on the grinding floor. In this instance the mill would not be large enough to require reduction machinery in duplicate. There were thirty-six divisions enumerated by the separating machinery up

stairs, not counting the scalpings, which would make forty-two. Such a scheme would require thirteen reels and, say, four or five purifiers for the separating machinery.

It will be noticed that no mention has been made of the distinct grades of flour. It is one of the beauties of the present system of milling that any desired mixture of flour products may be made. The ordinary way would be to make three grades, taking the flour from the four middle breaks, together with the first and second reduction of the dust middlings, for the clear flour; the flour from the first and second sizings and first and second middlings for patent. Then the flour from the first break, sixth reduction and first and second low grade stocks and bran duster flour would make low grade. Now there are changes which may be made in the low grade separations which would prove more profitable than the one just mentioned. They include the making of two low grades, taking the sixth reduction and the flour from the reduction of the first low grade stock for the first low grade, and the flour from the first reduction, second low grade reduction and the bran duster for the second low grade flour. On a mill operating on the basis of four bushels and thirty pounds of wheat, the first low grade, if made out of winter wheat, will grade a XXX St. Louis standard, while the second low grade will be a super of the same standard. There will be about twice as much of the former as of the latter. If the two were mixed they could not be much better than an extra. Now, as to which pays the best, is a simple question in arithmetic. If the writer mistake not, the XXX is an easier grade of flour to sell than any other. This is a question which every miller can decide for himself.

THE HUNDRED BARREL MILL.

CHAPTER I.

INTRODUCTION OF THE 100-BARREL MILL PROPOSITION—THE LIMIT IN PURIFICATION—GRADUAL REDUCTION OF MIDDLINGS.

In considering the processes and all the various details of milling, it is not remembered that any attempt has been noticed to show up the broad, underlying principles of flour manufacture as it is now carried on. These principles may be well understood and yet not expressed, or not expressed well. In passing over this idea as hastily as must be done here, it cannot be hoped to do it the justice that would be wished.

The purpose of the milling of wheat is to get it into such shape that it can be made into bread, the idea being to get the most money out of it, and the process of so doing is to make the most bread out of the flour. Thus we have, as a purpose, the most money out of the wheat, and, as a means, the most flour out of the wheat and the most bread out of the flour. It so happens that the most bread can be made out of the purest flour, the purity of anything being always estimated with reference to its complete fitness for the purpose for which it is intended. A thing might be spoken of as pure for one purpose when it would not be pure for another. The best bread is that which is best to eat, and the best flour is that which will make the best bread and the most of it. The best milling is that which will make the best flour and the most of it out of a given quantity of wheat. Now, if pure flour makes the best bread, the means of making pure flour is the logical sequence in this consideration. It is a question of process and the machinery to bring about that process automatically and economically. As to the process, and as a part of the desired end, reduction is the first great step, and separation the second. Purification is the controlling idea as to the quality of the product. Reduction is a necessity in order to get the wheat into flour form, and the success of the operation is the value giving element. Where the cleaning of the wheat has to do with the removal of the impurities which are a part of it, it belongs to the purifying process. If we could thoroughly purify wheat—if its impurities were all on the outside—we would never have had the middlings purifier in

the first place, gradual reduction in the second, or bolting machinery either, only in so far as it was desirable to grade the material—a necessity brought about by incomplete reduction. If such a thing could have been done, this machinery would have been entirely unnecessary, excepting as developed by imperfect reduction devices. The fact that there are particles of matter scattered throughout the grain of wheat which are deleterious to the bread-making qualities of the flour, was what developed the necessity for the middlings purifier as a purifier of broken wheat.

It was for the purpose of purifying the wheat that the middlings purifier was invented, and it was for the purpose of making more stock which could be purified—that is, middlings—that the system of gradual reduction was arranged. In the sense that a middlings purifier is intended for broken wheat, it is desirable that a large proportion of the stock should be maintained in this form rather than in the finer particles known as flour. The reason that middlings can be purified and flour cannot, commercially, is clear when the principles of the purification of middlings are stated. The impurities in middlings are either larger in size, less in specific gravity, or different in structure from the desirable portion of the middlings. In event of the impurities being larger, they may be separated from the middlings by the bolting cloth. In event of their being of less specific gravity, air currents are arranged so that the lighter particles may be sent in one direction while the middlings take their natural course in another. The separation according to the difference in structure is made by rolls. For instance, germ may be flattened while the middlings will be broken, or a piece of bran may pass through smooth rolls intact, while the middlings, which were of the same size as that piece of bran, would be broken into several pieces. By such an operation, the question of separation becomes merely one which has reference to the size of the impurities. The germs of the wheat being larger than the middlings with which they are mixed, is readily separated by bolting cloth, as before stated.

It is said that middlings are made in order to purify the wheat and for the reason that those impurities are not all external. It does not follow that the wheat can be purified by the mere reduction to middlings; and their treatment as such by the purifying agencies mentioned, but it does follow that the fracture of the wheat liberates certain of the contained impurities, and as there are impurities contained in the unreduced

middlings themselves which would get into the flour by an immediate reduction of the middlings after their handling by the purifiers, it follows that the gradual reduction of the middlings is as necessary as is the gradual reduction of the wheat. As this gradual reduction continues, so does the purification. Gradual reduction and purification go hand in hand. It is gradual reduction *and* purification. This is milling, and anything less complete is in the same degree incomplete milling.

There comes a point in the gradual reduction of the wheat when we cannot longer take off middlings of such a size as to commercially purify them. It then remains to take off all of the flour remaining on the bran. In the process of making middlings certain particles of the wheat and of the contained and other impurities, are broken into such fine pieces that they cannot be treated by the purifying agencies mentioned. It remains to handle such material on reels, taking out such part as is known as flour, and making a separation of stock which may be designated as dust middlings, they being between middlings and flour. The purity of this stock may be very much enhanced by the action of the smooth rolls and the following reels as purifiers, in that they remove a portion of the impurities.

The same thing happens in the gradual reduction of the middlings, though in that instance there is less effort to prevent the production of flour. But at the same time its production is gradual in order that the middlings may be of such a size as to admit of purification and other reductions. Milling is a process of reduction and purification, and in order that the purification may be more perfect, the reduction and purification must be gradual. The reduction of the wheat has in mind the production of middlings for purification. The gradual reduction of middlings has in mind their gradual purification in order that it may be more complete. It is more complete by being more gradual, because there are contained impurities in the middlings which are liberated or detached with each reduction.

CHAPTER LI.

CONSIDERATION OF THE REDUCTIONS AND SEPARATIONS NECESSARY FOR A 100-BARREL MILL—MECHANICAL AND COMMERCIAL CONSIDERATIONS FOR MILLBUILDING—COST OF FLOUR—QUALITY OF FLOUR—CONDITIONS INFLUENCING THE COST OF FLOUR—COST OF OPERATING A MILL—INFLUENCE OF HARD AND SOFT WHEAT ON THE PLANT—FIRST REDUCTION.

What reductions and separations are necessary in a 100-barrel mill? In answering a question of this kind it is well to consider in a general way what a mill of this size implies and what it does not imply. It does not mean simply the making of 100 barrels of flour in twenty-four hours, but, on the other hand, it does suggest the enumeration of the elements necessary to make 100 barrels of flour in that length of time, at a cost and of a quality which will admit of its being sold in the general markets at a fair margin under ordinary circumstances. An answer to this question which would be two years old, would not be an answer to-day. It requires a better mill to make money now than it did two years ago, and this state of the case would be true at this time, even though the unusual conditions influencing the market were not present. The mechanical and commercial considerations in millbuilding must go hand in hand. A miller cannot run his mill on the reputation of a single grade of flour, say patent. He has to make a good patent—a fair percentage of it—a high grade clear, and a small percentage of low grade which is well bolted.

The merit of flour plays a more important part in its sale that it once did. Not but that merit is necessary, and always necessary. It will be remembered that certain high grades of flour once had a reputation which stood up like a stone wall. As long as the quality was uniform, it was not so much a question of price as it was of getting the flour. Outside flours of equal merit and less cost could not easily force their way into the lines. It was sold by the name on the barrel, and no one took the pains to examine it when making the purchase. It is not so now. The best established brands, in many instances, have to compete

with other flours of equal merit. Therefore it may be said that the matter of quality, independent of reputation, is gradually playing a more important part in the sale of flour than it formerly did. Not but that reputation is valuable and does make a difference in the sale of flour, but it is undeniably true that it is easier to work in a truly meritorious flour now than it was several years ago. There is one element of reputation which a miller may have and always profit by—an element which it is hard to disturb—and that is the reputation of furnishing a uniform grade of goods. A dealer may pick up a sample on 'change in New York and say: "Here is a flour which is as good as Smith's," but he cannot say that the next lot or shipment will be as good as Smith's, and for that reason if he buys the former it would be at a difference in price which would probably leave Mr. S. a milling margin.

It is not so much a question of choice how much of a mill a man builds now, how complete it is in system, as to the number and quality of the reductions, as it was formerly. A miller who intends to compete with or do business in the general markets, cannot say: "I will build a three or four break mill and other things in proportion, and content myself with a smaller margin than if I chose to invest more money." Where he has only three or four break mills and buhr mills to compete with, mills which do work of that quality and cost, that may be all right, but demand and supply suggest something different. The demand is for the best thing, and the supply is by more elaborate means than those of a three or four break mill, hence a competition on a more elaborate basis. According to this it is not a matter of choice as to how complete the milling system may be, but a question of demand. It is a question which is settled by the goods on the market and the means of making those goods.

The next question is as to what is the demand of the market as to the quality of the goods, and their cost as well. The quality of flour is a difficult thing to describe on paper. One might write forever and not be able to convey to a man born blind what is meant by a color, and especially the names of the colors. There is no definition which will convey to one's mind the idea of redness. At the same time there is no means of describing in print the quality of flour. One may speak of a patent and a general impression is conveyed, but as to the quality of the patent he is left in the dark. One cannot estimate quality by the prices, because that is a variable quality. Comparative merit, in the

absence of fixed and recognized grades of differences, is the only basis for consideration. We can only say that we have to meet the market as to quality, that we want to make flour as good as the best, taking into consideration the quality of wheat used. Hence, knowledge of what is the best and knowledge of the demands of the market is a necessity to him who proposes to erect a mill to meet the demands of that market.

The cost of flour may be influenced, (1) by the cost of the operation of the mill; (2) by the amount of stock used; (3) by the proportion of the various grades made; (4) by the value of the various grades. Three of these conditions may be favorable. and a fourth being neglected, the profits of the mill may be seriously impaired. For instance, the expense of running a mill might be exceedingly low, the quality and yield all right, and the amount of stock used down to a reasonable basis, and yet, because of a neglect of the percentages, the profits of the mill might be destroyed. It should be remembered that the question of yield is to be estimated not alone by the amount of stock used, but as well by the percentage of various grades of flour derived therefrom. There is still a better way of estimating than this, and that is the proportional increase in the price of the wheat, as influenced by its milling. That is, the mill which will take a bushel of wheat and add the most value to it is the best mill. This is the quality in mills which it is difficult to estimate, but it is clearly to be seen that the question of the product is inseparable from that of yield, when properly considered.

The cost of operating a mill is influenced by mechanical considerations—the quality of the machinery and the convenience of its arrangements. A consideration of these elements would develop a more lengthy description than it is well to make here. The amount of stock used, the proportion of the various grades and their values, is to be met by the quality of the machinery as adapted to its uses, the arrangement as forming the milling system, and the skill with which it is operated.

All this has direct application to a 100-barrel mill, as it has to one that is larger or smaller, and in any mill there is the embarrassing feature of hard and soft wheats to be considered. One could very easily work out a plausible theory to show that the amount of grinding surface could not be influenced as to its capacity by the hardness or softness of the the wheat on any one of the reductions. The basis upon which this idea would be worked out would be that the proper grinding capacity of

a pair of rolls is a fixed quantity, fixed by the amount of material which will pass through the rolls, each granule of which will be evenly touched on both sides. Any more than this would result in the various particles being mashed together and not reduced by the rolls themselves in the strict sense of the idea. The same fine spun theory would point out that a less amount than the proper fixed quantity of stock would involve the waste of good milling machinery. This idea that the grinding capacity of a pair of rolls is fixed on various qualities of stock, would be drawing entirely too fine a bead on the whole business. The fact is that a mill can make more flour in the same number of hours, with the same amount of machinery, out of hard than it can out of soft wheat, and not alone on account of the fact that the hard wheat bolts more readily than soft, but because it is more readily reduced. Soft wheat assumes greater bulk in the process of reduction than does hard. By this is meant that, say on the third or fourth reductions of the wheat, there will be a larger amount of stock to be reduced in the case of soft wheat than of hard. But at the same time the difficulty of reducing soft wheat is greater than that of hard. It is more tenacious—holds together longer; it occupies more space and is more bulky. In the wheat reductions the bran is larger. When it comes to reduction of middlings by smooth rolls, the work has to be done more slowly with soft than with hard wheat. Take the case of the very large middlings—the middlings which are to be sized. It takes a greater number of reductions to bring the middlings down to the proper size, and at the same time preserve their quality with soft than with hard wheat. Furthermore, this same principle applies equally all the way through the mill—to the dust middlings and red-dog stocks alike.

It takes more mill to make 100 barrels of flour out of soft wheat than it does out of hard—the time being the same, of course. A mill which would make 100 barrels of flour in the twenty-four hours out of four bushels and thirty pounds of soft wheat, will make more than that amount of flour out of hard wheat with the same yields. This thing sometimes occurs in mills which run to a uniform capacity, which regulate their grinding by the packer registers—mills which make 100 barrels of flour in twenty-four hours, regardless of hard or soft wheat. With regular grinding this will sometimes occur. They may be grinding soft wheat and making 6 or 8 per cent. of low grade, but, on changing to hard wheat, they may make from 10 to 12 per cent. of low grade. With this result the

conclusion might be reached that the "hard wheat made too much low grade." Not so, however. It is simply meant that the yield was better, and that the miller was getting more flour out of the tail end of the mill—that he is getting more flour into the low grade packers and less into the feed pile. If he had increased the production of flour when changing from soft to hard wheat, the amount of low grade might have been the same and the yield the same.

In hard wheat milling the size of the middlings is more nearly uniform and consequently fewer operations are required in their reduction and purification. The number of classifications for the latter purpose need not be so great. The matter of sizing and purification between sizings is much more important in the case of winter wheat milling than with spring wheat. Not but that sizing is necessary in both, but more sizing and more intermediate purifications are necessary in the former case than in the latter. All this that is said about grinding capacity goes to show how uncertain and how unreliable a direct and dogmatic answer to the question as to how much machinery is necessary for a 100-barrel mill, would be. The safe thing to do on winter wheat will be to take Fultz wheat of the ordinary degree of softness as a basis. Then if the wheat be harder, the capacity of the mill will be greater.

Take the first reduction: One pair of 9x18 rolls is about right. Less would do for this reduction, from the fact that a first reduction never fulfills its promises. It does not split the wheat with any degree of uniformity, and it does not release the "crease dirt" to any great extent. Eight corrugations to the inch is the usual thing at this stage of the proceeding, though various other arrangements and combinations are frequently mentioned and vouched for—such as a coarsely corrugated roll run against a smooth roll, the running of the dull backs of sharp cut rolls against each other, and the running of them at various differential motions, and at integral motion; that is, both rolls at the same speed. From 200 to 225 revolutions per minute is the proper speed. The scalping reel should be clothed with No. 20 wire, though coarser middlings than this would be made on an eight corrugated roll. As far as the separation goes, this scalper need not be more than two feet long, but as a longer reel does good service in other respects, it is well to have it of greater length, say four or five feet. The flour reel from this break need not be over twelve feet long, the first two-thirds of it being clothed with No. 14 cloth. The coarse middlings which go into this reel will

make it bolt abundantly free, so that lack of capacity need not be feared. No. 8 cloth at the tail, the product of which can be sent to the low grade rolls, will dust the coarse middlings sufficiently and free them from the lighter impurities to such an extent that they may be sent to the grader, or to the scalpers, if the grading be done in that way.

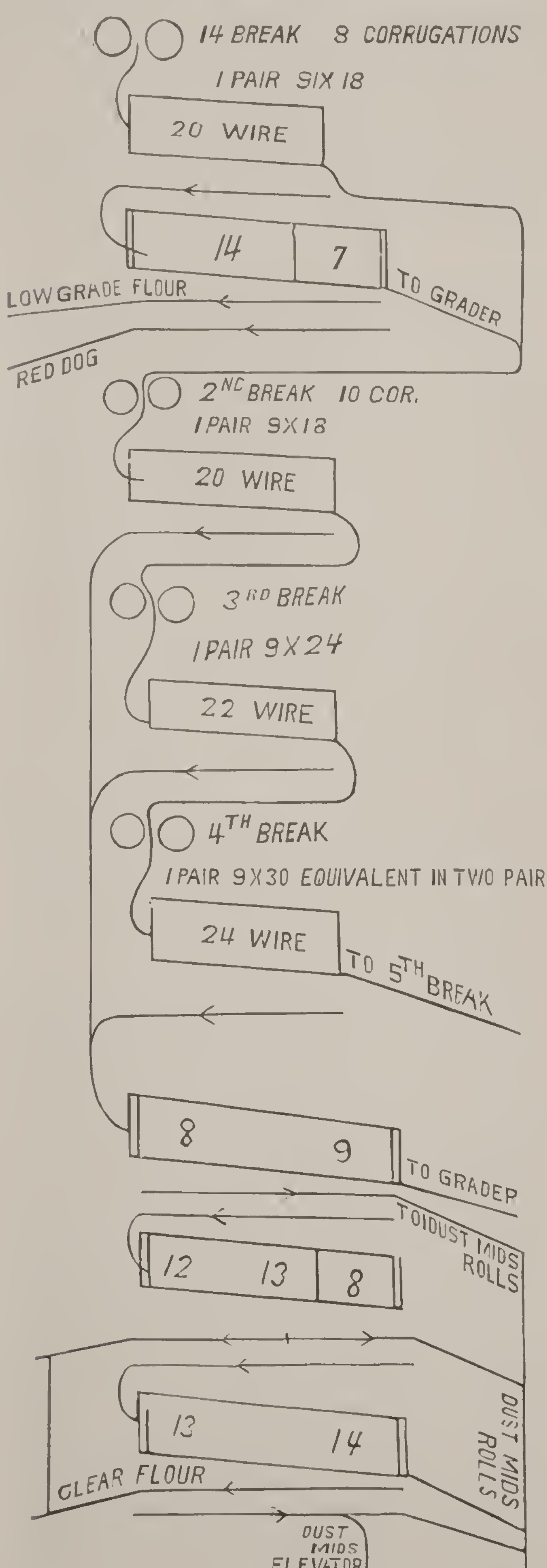
CHAPTER LII.

THE RELATIVE AMOUNT OF MACHINERY FOR A 100-BARREL MILL—MACHINERY FOR SMALL MILLS—CONSIDERATION OF THE FOUR MIDDLE BREAKS—PRODUCT OF THE FOUR MIDDLE BREAKS.

The same principles apply to the construction of 100-barrel mills, or other small mills, as to larger ones, although, in the latter, finer points of reduction and separation can be recognized. In the last year or so we have heard a great deal about machinery for small mills—reduction and separating devices—being various arrangements which propose to do the same work at a less cost of plant than if done by the regular milling machinery in general use. For these same small mills has been arranged reduction machinery, the claim for which in some instances is to do in a single operation what is done in other instances in larger mills by two or three reductions, and, at the same time that this short cut as to the expense of milling the wheat is claimed, no allowances are made for an inferior quality of work. Now, all this is preposterous; not but that it is desirable to make special and less expensive machinery for small mills, but on account of the claims of the quality of their work as compared with the more complete and logical methods.

It will be remembered that soon after the gradual reduction process was first announced, various competing millstone dresses were brought out, the inventors of which, in some instances, announced that they had accomplished the whole business between the eye and the skirt of the millstone. These claims have gradually been softening down, and as time passes they approach a more reasonable basis. Still they have not yet fully reached the point where it is recognized that the machinery which is best adapted for a large mill is the only proper machinery for small ones which desire to do the same quality of work. In point of fact it is merely a question of reduction and separating capacity. To be strictly logical or reasonable, it may be well to say that the length of the rolls and the number and length of the reels and the size of other reduction and separating machines marks the difference in capacity.

The question of quality of machinery cannot indicate the capacity of the mill. The fact that a mill is making 100 barrels of flour in twenty-four hours does not suggest the idea that its machinery is in any way inferior to one which is making 500 in the same length of time.



This fact is being recognized by some of the large millbuilding concerns, who are making machinery of the same general designs and of the same quality, but smaller in size and capacity than that used in the larger mills. Another idea on this same line is a point in regard to the often asked question as to whether small mills can be made to do as good work as the large ones—can compete with the latter. They can, but as a matter of fact they do not. They can do as good work if arranged on the same basis and operated with the same skill as the large ones, but, as a rule, a single pair of 9x18 rolls will have from a half more to twice as much work to do in a small mill as a large one. The same is true as to the reels and purifiers. The reduction and separating devices are more often overworked in small than in large mills, and for that reason the latter more universally do work superior to that of the former.

In the last chapter the first break was considered and the course of the stock fully illustrated. A diagram of this break and the separations as previously

described, together with the breaks and separations of the second, third and fourth reductions, is herewith submitted. The second break is made on one pair of 9x18 rolls with ten corrugations to the inch. Twelve are sometimes used, and occasionally even finer, but the writer prefers the former, as it leaves the stock in broader shape—not so much cut up—for the third break. No. 20 wire is used on the scalper, which is six feet long. Were hard wheat used on this mill, a shorter scalper would do.

The third break is made on one pair of 9x24 rolls, with fourteen corrugations to the inch. This corrugation, as understood, suggests No. 22 wire. As said before, the size of the middlings is largely influenced by the size of the corrugation, the quality of the stock being such as is demanded by the reduction of this corrugation. The third break scalping reel in this mill would be about seven feet long.

The fourth break reduction is made by thirty inches of reduction surface, corrugations sixteen or eighteen, preferably the former, with the reel eight feet long, it being well understood that, as the reductions advance, the length of the reel should increase. The quality of this stock and number of the corrugation invites the use of No. 24 wire. It is well known that all of the middlings made on each reduction should be taken out on the scalper for that reduction, and that if the scalping wire be not accommodated to the number of the corrugation, or the size of the middlings made, the idea and purpose of gradual reduction methods will not be fully realized, in that middlings may be carried over from one break to another, or, in case of the wire being too coarse, larger stock than is desirable will be carried in with the middlings, which would, in order to get rid of the stock properly, invite the use of a larger plant of smooth rolls, scalpers and purifiers than is usual or desirable.

The product of the second, third and fourth breaks is run together, the fifth break chop being cared for by itself, as will be described later. The middlings from the three breaks named are scalped over Nos. 8 and 9 cloth—this and the two following reels being fourteen feet long. The tail of this scalper goes to the grader. It will be noticed that the upper conveyor is arranged so that any part of the tail of the middlings scalper may be sent direct to the dust middlings. If this stock should have the flour all taken out of it—should be sharp and ragged—there is no need of sending it to the flour reels. The same arrangement may be noticed at the tail of the next reel. In either case, if desirable, the entire product of that reel can be sent to the one next lower by merely closing

slides. The flour numbers on the second reel are Nos. 12 and 13, and the tail or scalping number is 8. The second flour reel is clothed with Nos. 13 and 14. The cut-off from the bottom conveyor can be sent either to the dust middlings rolls or the dust middlings elevator. In one instance it would be reduced; in the other it would not, this depending upon the quality of the flour. It is understood that the tail of this reel will always go to the dust middlings rolls.

CHAPTER LIII.

THE FIFTH BREAK—ARRANGEMENTS FOR CARING FOR THE PRODUCT OF THE FIFTH BREAK.

Next in order comes the fifth break. It is on this break that the results of good grinding can be clearly realized. The product of the third and fourth breaks is pretty sure to be reasonably good under any circumstances, but any differences on these breaks will operate to the disadvantage of the fifth. The point in good grinding is always to keep the stock as broad as possible—to maintain the bran in large flakes. What we want to do is to reduce the flour stock and come as near as possible to letting the impurities alone. If we could get the bran from each kernel in one piece, we would be reasonably certain of getting little or none of it in the flour. The same thing applies to other impurities, but as this is impossible, we do the best we can. We say that we will keep the bran broad, and, in other respects, disturb the deleterious stock as little as possible. Hence, the best grinding is that which comes nearest this point.

It is particularly desirable that the stock go to the fifth and sixth breaks in this broad condition, and for that reason we must look to the other breaks—to the part of the mill ahead of these—to bring about this desirable result. The same grinding which will do this will reach the best results in other respects in the first four breaks.

With soft wheat we can grind a little closer on the first two breaks, and still not disturb the bran for the latter breaks, than we can with hard wheat. With this kind of grinding on the wheat mentioned, it is possible to grind more open on the third and fourth breaks than would otherwise be allowable in order to get the proper final finish. By the means here suggested, the middlings on the third and fourth breaks from the soft wheat will be large, more readily dusted in that there will be less dust made, and brighter and freer from bran and bran specks. They will also be less inclined to be mushy or soft, and at the same time the quantity will be greater. In the case of hard wheat the grinding can be more uniform throughout, but should be less close on the first and

second breaks, and with the idea of "grinding for middlings" on the third and fourth breaks, the desired results as to the delivery of stock to finishing breaks will be realized.

In a 100-barrel mill the fifth reduction should have thirty inches grinding surface to do the best work. It was a custom a few years ago, and one that is not altogether wiped out, to contract the amount of grinding surface after the fourth break. If anything should be done, it should be increased, the stock being bulkier and requiring more surface to properly operate upon than upon the previous break. This break requires more delicate handling, finer distinctions as to the adjustments, and altogether more intelligent handling, when considered by itself, than do any of the other breaks. Twenty corrugations to the inch are unquestionably the best for this reduction, and No. 26 wire, or the corresponding size of grits gauze is used for the scalpers. Eight feet is the proper length for the latter.

A mistake is made in running the product of the fifth break in with that of the other middle breaks: that is, the second, third and fourth. As a general thing, it will be found that the quality of the flour from the fifth break is superior to that from the second, but that the middlings are very much inferior, and with soft wheat not only is the quality inferior, but the quantity is small. The amount of middlings from this break is even less than is usually supposed. There are some very fair middlings which will pass through a No. 4 cloth, but even these are not of the right quality to go in with the middlings from the other breaks. This is more particularly true of soft wheat stock. The material which will tail over a No. 4 cloth is little better than tailings.

On a plant of the size of the one in question, the diagram in Fig. 1 indicates the solution. The tail of the No. 4 cloth goes to the tailings; the product of that cloth, considering the size of the plant, goes to the dust middlings; a portion of the flour from the upper conveyor goes to the bakers'; and the cut-off to the dust middlings flour reel. This can be done by spouting it directly into the elevator which takes the stock from the dust middlings rolls.

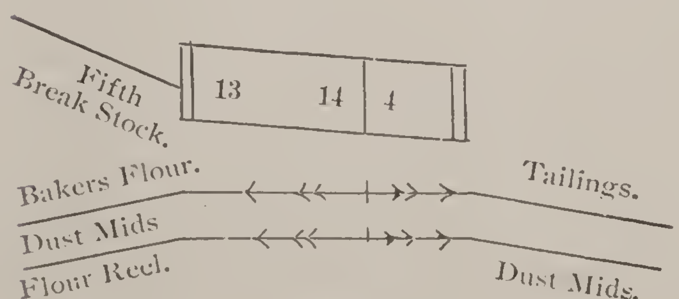


Fig. 1.

The diagram in Fig. 2 indicates another means of handling the same

stock. It will make better flour and better separations generally. The coarse stock is sent to the tailings as before, and the product of the No. 4 cloth to the fifth break middlings purifier or purifiers. The stock which goes through the No. 8 cloth on the upper reel has enough of coarse material taken out of it so that it will bolt clean and bright on the reel below. There is one point to which the writer clings very strongly, and that is to reducing the proportion of sharp material to the utmost degree consistent with the possibility of bolting it before taking out flour. The progress of the stock is sufficiently indicated on the latter diagram so that further explanations are not necessar

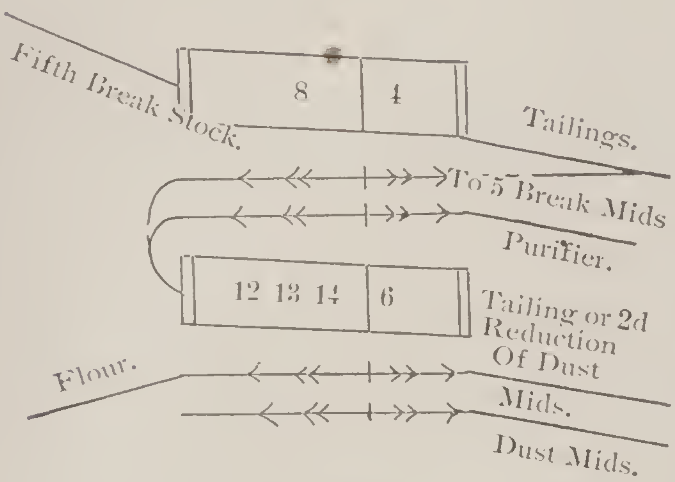


Fig. 2.

CHAPTER LIV.

THE SIXTH REDUCTION—CAPACITY REQUIRED FOR THE SIXTH REDUCTION—OVERLOADED BRAN ROLLS—SCALPERS FOR SIXTH REDUCTION—DIAGRAM FOR BOLTING SIXTH REDUCTION STOCK—SIXTH REDUCTION FLOUR.

The sixth reduction of the wheat being the last, it is well that it have due consideration. It is the last reduction of the wheat proper, and at the same time it is the first reduction in the process of milling where we begin to throw stock into the feed pile. It is spoken of as being first, perhaps not in its milling sense, but first in general classifications. In considering a mill in this way, it is natural to take the breaks first, and then the products of these breaks, considering in due order such as are of first importance in the division—the middlings. Then there would come the finer stock as to size, not quality, and next the coarser, or red-dog stock. If we were to consider that which went into the feed pile first in point of time in the process of the milling of the wheat, it would probably be a portion of the reduced red-dog stock from the first reduction, this material making the shortest cut from the wheat to the feed pile. This statement is a mere novelty, and has no special significance or value from a milling standpoint. It is like answering a question which one frequently hears from mill visitors as to how long it takes the wheat to get through the mill.

But to return to the sixth reduction: Only a few years ago, in most of the diagrams then made, the capacity of these rolls was much less than that of the middle reductions and usually about the same as the first. The character of the stock which goes on these rolls invites a different condition of things. It is bulkier, occupies more space, requires a larger elevator to carry it than the others, and requires more reduction surface to handle it than any other breaks in the mill. But one has to preserve a little policy in these matters, and the most that can be suggested is that the sixth reduction should have fully as much grinding capacity as any other in the mill. The sixth being the last of its class, and being one which sends a larger

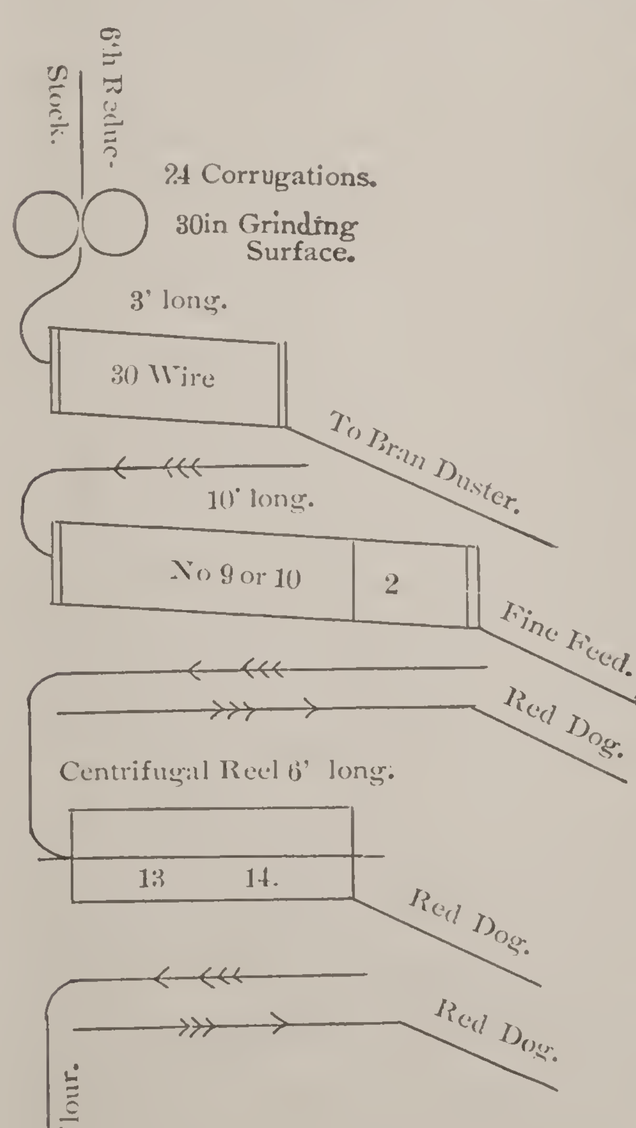
quantity of material to the feed pile than does any other, it is important that this work should be done thoroughly and well. Where the capacity is limited, the quality of the finish at this point must necessarily be materially influenced, and in a way to have a very decided bearing on the cost of the flour. The amount of grinding surface which will do the best work at this point in the mill is that which will come nearest to scraping each particle of bran. This word scraping is used not because it is entirely satisfactory in this sense, but as being the one which most nearly conveys to the mind the idea of the proper mechanical process in the reduction of the stock under consideration. The words breaking or grinding lose their true significance in this part of the process, having presumably a proper significance only when applied to the making of middlings. The process which will most thoroughly scrape the flour from the bran without fracturing the latter, is the one which most thoroughly realizes the idea of its cleaning or finishing.

Where the bran rolls are overloaded, only a certain proportion of this stock is submitted to the action as above described. The material which is in excess of the natural or proper capacity of the rolls is influenced only by compression, by the friction of one particle against another, instead of by the scalping influence of the rolls themselves. The same ideas which were mentioned with reference to the condition of the stock as it passed to the fifth reduction, as applying to its desirable broadness and freedom from flour and fine stock, applies with equal force to the sixth reduction. The writer has seen stock from the tail of the tailings roll reel run to this reduction, and also material from the tail of the sizing reel. Whatever benefit there might be gained from the material in question, it is largely overbalanced by its bad influence upon the proper stock for these rolls. In the first place, it will not feed so regularly or evenly, and in the second place it greatly interferes with the reduction of the bran.

In this 100-barrel mill thirty inches of grinding surface is necessary for the desired results, twenty-four corrugations to the inch is dictated by general experience, and No. 30 wire is commonly used. The best scalper for the sixth reduction is a common form of centrifugal reel. The device which is in mind can hardly be called a reel, in that the outer cylinder does not revolve, but has the spiral beaters on the inside to agitate and propel the stock. It is not known that such a machine is regularly on the market, though it was several years ago, being sold and

improperly used for scalping wheat chop from millstones. Considering their cheapness and the quality of the work done as a sixth reduction scalper, it is strange that they have not been made and sold for this purpose. A scalper six feet long, of the kind mentioned, will take the stock from a 500-barrel mill and make a very superior separation on this class of stock; that is, there will not be a suggestion of detached flour or middlings on the bran as it leaves the tail of the machine. Scalpers three, four and five feet long might be made; the first size would be ample for a 100-barrel mill. They are a terror to the miller in the matter of keeping the cloth whole, until he strikes the idea of putting on a coarse cloth of about a quarter inch mesh and finer inside of that, the cloth being put on from the inside of the reel and divided in half longitudinally. The coarser cloth is secured with double pointed tacks, or small staples.

The diagram given here shows the reduction and separation of the sixth break stock, the tail of the scalper going to the bran duster, and the tail of the reel to a secondary scalper which makes three separations, viz.: the flour stock, the red dog stock and the fine feed or shorts. The quality of the former can be regulated by the quantity of stock sent to the red-dog. This separation of the flour stock from the coarser material should be made on as fine a cloth as possible, or one which would make the separation itself without running rich material to the red-dog, keeping in mind only the possibility of bolting this material on the centrifugal reel below. This is done with the idea of reducing the proportion of coarse material in this flour stock to as great an extent as possible, thus getting a better quality of flour from the centrifugal reel bolting this stock than would otherwise be possible.



The flour from this reel would be white and bright looking under the spatula, though its doughing qualities are not sufficiently good to admit

of its going in with the high grade. It is dark in the dough, but is the strongest flour in the mill. Its color when wet is the only thing against it. At the same time that it cannot go with the high grade flour, except in occasional instances, it is very much superior to the red-dog flour, and in a small mill it is a problem what to do with it, but in any event it will pay to pack it by itself. This will not require any additional packer, but by submitting to the inconvenience of running it into sacks and packing it once or twice a week on the low grade packer, it will be found that the inconvenience is more than overbalanced by the return to the miller.

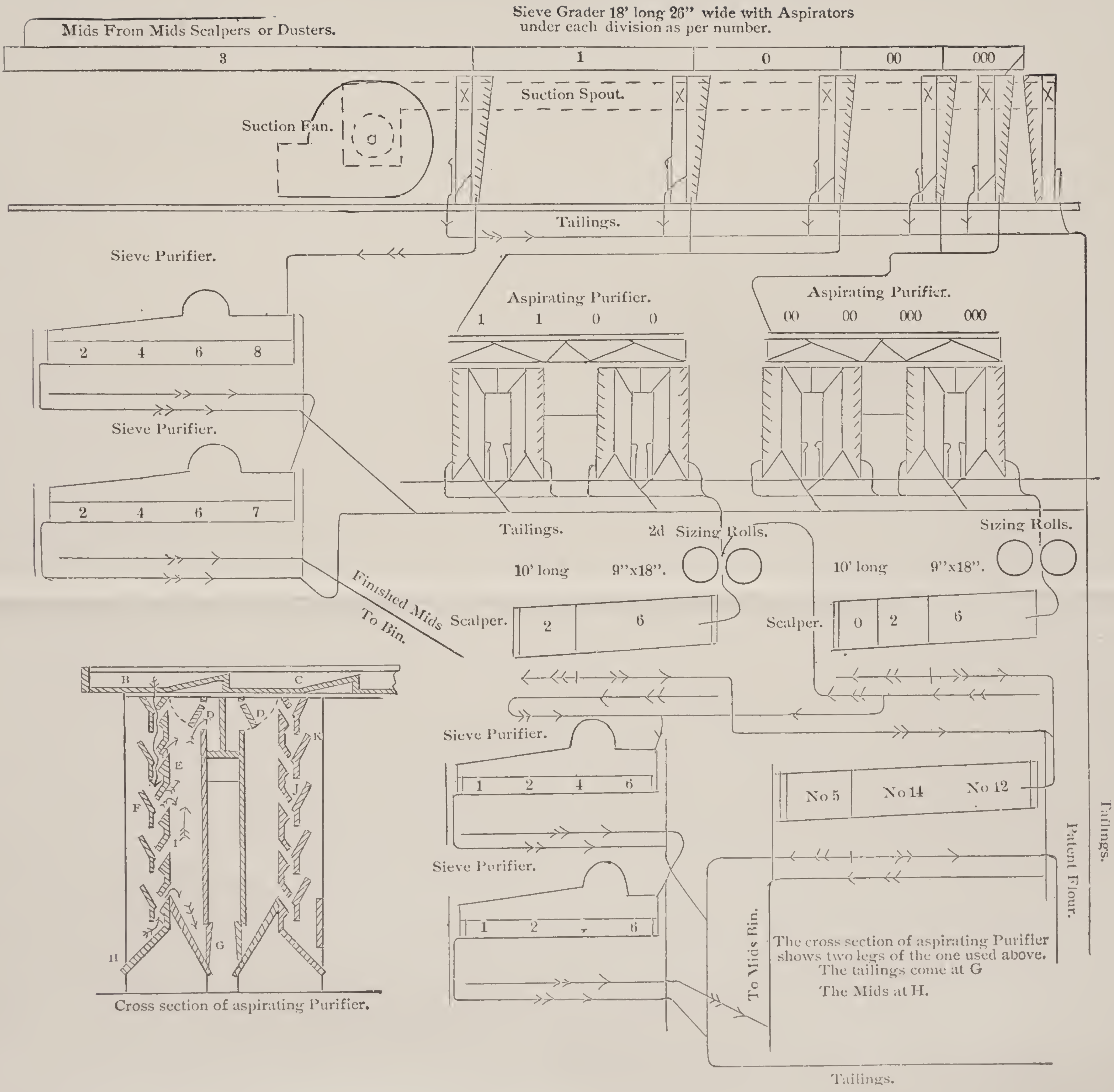
CHAPTER LV.

PURIFICATION FOR A 100-BARREL MILL—GRADING OF THE STOCK—GRADUAL REDUCTION OF THE MIDDLINGS—USE OF ASPIRATORS IN A 100-BARREL MILL—USE OF SIZING ROLLS—THE ANALOGY OF THIS METHOD TO HUNGARIAN METHODS.

The cut here given represents the diagram which gives the purification system for the 100-barrel mill. It will be noticed that there are five grades on the grader and three grades for purification—two of the divisions made by the grader being run together before they pass into the aspirating purifiers. The first grade, which goes through a No. 3 cloth, passes on an ordinary sieve purifier. The middlings which pass through the Nos. 0, 00 and 000 cloths, after having passed through the aspirating purifier in two divisions, are sized on smooth rolls. The Nos. 00 and 000 grades are sized down to the No. 0 grade and the No. 0 middlings to No. 2. These numbers—the No. 0 and the No. 2—may be noticed under the sizing rolls for the grades named.

The stock which passes over the tail of the No. 0 in the first sizing and the No. 2 in the second goes to the tailings. The stock which passes through the No. 0 of the first scalper goes to the second sizing rolls, and the stock which passes through the No. 2 cloth goes to the sizing purifiers below. The fine middlings and flour which pass through the No. 6 cloth go to the flour reel below. The material which passes through the No. 5 cloth on that reel goes to the middlings bin. It is arranged so that any portion of the product of that No. 5 cloth may be sent to the tailings. It would very seldom be regarded as necessary to send more than one slide of that stock in that direction.

It will be remembered that the writer has referred to smooth rolls as purifiers. They are used especially for that purpose in this diagram. It is hardly necessary to go farther into the description of this diagram. It may be well to note, however, that the aspirating purifiers have four legs, each of which is connected with a suction fan in the middle. A detailed drawing of two of the legs of this purifier is shown in the cut.



Sieve Grader 18' long 26" wide with Aspirators
under each division as per number.
Mids From Mids Scalpers or Dusters.
3
1
0
00
000
Suction Spout.
Suction Fan.
Tailings.
Sieve Purifier.
2
4
6
8
Aspirating Purifier.
1
1
0
0
Aspirating Purifier.
00
00
000
000
Sieve Purifier.
2
4
6
7
Tailings.
2d Sizing Rolls.
Sizing Rolls.
10' long
9"x18".
10' long
9"x18".
Finished Mids
To Bin.
Scalper.
2
6
Scalper.
0
2
6
Sieve Purifier.
1
2
4
6
No 5
No 14
No 12
Sieve Purifier.
1
2
6
To Mids Bin.
Patent Flour.
Tailings.
B
C
D
D
E
F
G
H
I
J
K
Cross section of aspirating Purifier.
The cross section of aspirating Purifier
shows two legs of the one used above.
The tailings come at G
The Mids at H.
Tailings.

The cross section shows a gravity separator or aspirator, which may need a little explanation. It is a form of purifier which is largely used in Hungarian milling. Not this particular one, but of the same kind and general principles. The purifier here illustrated is a suction machine. The direction of the suction is between the slats *E* and *F*, and toward the opening *B*, the size of which opening and the force of the suction being regulated by the valve *E*. The middlings pass between the slats *E* and *F* in a downward direction, and are deflected from side to side, their progress being arrested by these. The suction draws the particles of less specific gravity than good middlings through the openings *J*, and over the slat *E* into the chamber at the back thereof. The air, after it passes through the narrow openings, expands to a certain extent and allows the larger portion of the impurities to settle and discharge through the opening *G*, which has a slat covering it in a manner similar to that of the discharge of a separator shoe. The pure middlings discharge through the spout *H*. For this kind of a purifier it is important that the middlings passing down each leg or compartment should be graded very close. There should not be the difference of more than one number from one compartment to the next, or from one size to the next. By this means the suction can be adjusted according to the specific gravity of the middlings and thus make a nicer distinction between the specific gravity of the good middlings and the impurities. With such a machine there is the grading sieve above, represented in the cut by *A B*, which is arranged to grade the middlings into the different grades. Under the grader there is a single leg of one of these aspirators, which is connected with the suction fan as shown in the cut. The sieve above the grader stands on hickory springs and has been described. The motion of the sieve should be from 325 to 350 per minute, and the throw about one inch.

Those who have read this work carefully will remember that the writer includes the system of sizing in the purification arrangements, believing, as he does, that present knowledge on that subject demands the use of smooth rolls and the following scalping reels as purifiers. To make this belief more emphatic and clear, he will say that if he had to make a choice for the purpose of purification between smooth rolls and the ordinary sieve purifiers, he would choose the former rather than the latter.

By reference to the diagram mentioned, it will be seen that the middlings from No. 1 to No. 000 inclusive, are reduced so that they will all

pass through a No. 2 cloth. It would be better to give these middlings still another reduction, so that all would pass through a No. 4 cloth, but this would invite a larger outlay than is usually thought desirable in a mill of this size. It is not possible to reduce winter wheat middlings any faster than the diagram indicates, and at the same time preserve them in that form which makes it possible to repurify the coarser product before it is finally reduced to flour. If they are reduced more rapidly, the product will be flat rather than round, or, more properly speaking, rectangular. If the middlings are flat, rich stock may tail over the machines, and the pressure used in making them flat will force the impurities into the middlings stock, rather than separate it therefrom. With extremely hard wheat it might be possible to do this work faster, but the difference would be such as to admit of a less number of reductions than those here given. Hard wheat middlings break into a larger number of pieces under the influence of the sizing rolls. This not only implies a more rapid reduction, but as well a larger proportion of fine middlings and a smaller proportion to repurify after the scalping. These facts might make it possible to clothe a little finer on the tail of the scalpers than was given in the diagram.

The sizing rolls are set according to the stock which tails over the tail number of the scalping reels. For this reason it would be well to send the tail spout from these reels down to the first floor on their way to the tailings elevator, in order that examination thereof may be readily made in connection with the setting of the rolls. If the rolls be too open the stock will be rich, and if they be set too close it will be too rich—in the first place because the stock will be too large, and in the second place because it will be too flat. If this stock be flat, it will be next to impossible to get the flour out of it on the tailings rolls, and the same poor sizing which will make this class of tailings will also make the larger class of middlings so soft and flat that they cannot be purified. Middlings which have been treated in this way once have passed the point beyond which the purifiers can fully benefit them. Furthermore, the following rolls or reduction machinery cannot do their work as well on this class of stock in any respect as if it had been properly treated. The quality of the flour will not be as good, either as to color or granulation—which implies quality—or as to the amount thereof, which suggests the question of yield. After stock has been flattened once by the rolls, it has a tenacious, feathery quality which renders its farther reduc-

tion slow, expensive, and finally incomplete. This merely goes to show that poor work on one reduction carries itself through the mill, affecting the quality of every following reduction and separation.

The system of purification in American mills is not nearly so complete as in the Hungarian mills. This is the one place where our milling is decidedly inferior to theirs. As understood, our arrangements for bolting the break chop in reduced middlings are superior to their method. but in the essential feature of the gradual reduction system, the purification and gradual reduction of middlings, our arrangements are very much inferior to the Hungarian methods. Our neglect is in the purification of middlings during the process of sizing. It is true that the automatic way of handling stock in American mills is so different from the Hungarian method of handling by hand that the same classification is impossible. While the adoption of the details of the Hungarian method is hardly possible, the principles are readily adaptable. and in neglecting those principles we are neglecting the best part of Hungarian methods. The part of that system which we have adopted is the making of middlings, but the better part of their purification and sizings we have neglected. This system includes the gradual reduction and gradual purification of the middlings. It is the combination of the purification by the ordinary methods—that is, by the purifiers—and the sizings, in one system.

While speaking of the neglect of possibilities in the benefits to be derived from milling on the Hungarian plan, it might be well to call to mind the cleaning of the wheat. So far as the writer is able to learn, their methods are very much superior to our own in this respect, and their arrangements of machinery for doing this work quite different from ours, though some of our machinery is used in their mills. There are very few mills where the wheat is well cleaned and scoured, and, as a matter of fact, very few changes or improvements have been made in this part of the mill since the days of low millstone milling.

To recur again to the diagram of the purification system of the 100-barrel mill: The system there suggested is a mere approach to the ideas just expressed in regard to Hungarian purification methods. It carries that idea about as far as can be expected in a mill of the size of the one under consideration. It might be asked, why not send the middlings from the sizings rolls—that is, those which go through the tail cloths. or the tails of the reels which follow the rolls—to the first sieve

machines, under the head of the grader, rather than to separate machines as shown? It may be well to call to mind in answer to this, that middlings which have once passed through the sizing rolls are of a different character from those which come from the break rolls, and for that reason demand a different handling.

CHAPTER LVI.

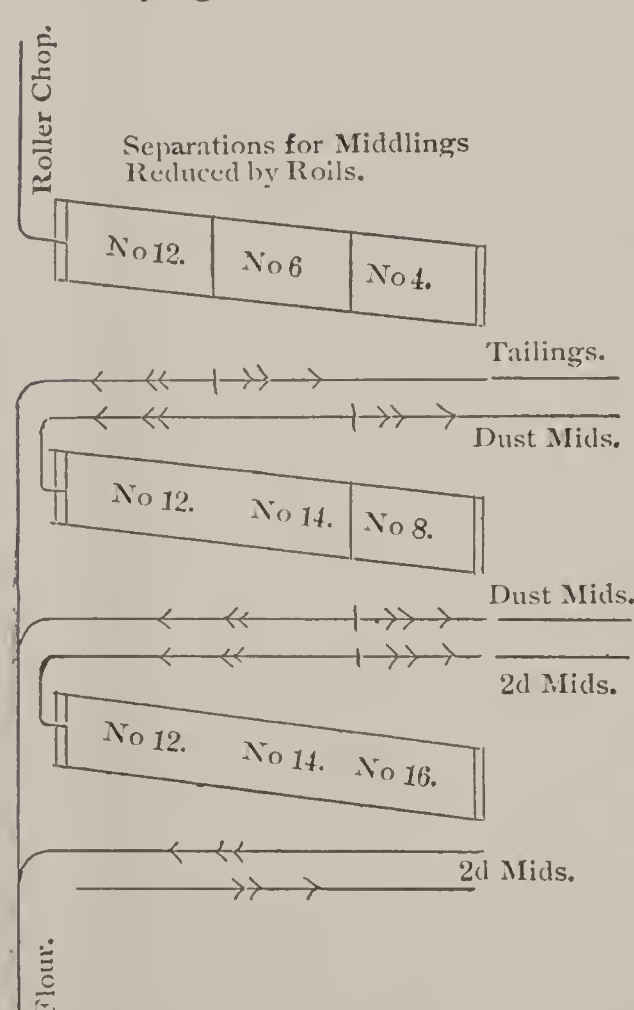
REDUCTION AND SEPARATION OF MIDDLINGS FOR THE 100-BARREL MILL—SEPARATION FOR A REDUCTION BY ROLLS—SEPARATION FOR MIDDLINGS GROUND ON BUHRS—THE SECOND MIDDLINGS—THEIR REDUCTION BY ROLLS.

Herewith is given the arrangement for the reduction and separation of the purified middlings. The clothing of the reels, and more particularly the fixing of the scalping numbers, should be considered in connection with the grinding. It is well to know how rapidly one intends to reduce the middlings, and then, by considering the size of the middlings to be reduced, it will be determined what the scalping numbers shall be. These are more important than the flour numbers, as by the scalpers the quality of the flour from any flour number may be influenced. It may have been noticed that the system of bolting followed out in this work has involved the gradual separation of the coarse from the fine material; that the idea has always been to keep the stock as soft as possible while in the reels, consistent with its bolting with ordinary facility, without the use of wipers, knockers or other makeshifts. Such a system always brings the whitest flour possible out of the stock. By reference to the diagram in Chapter LV., it will be seen that the middlings are dusted over a No. 8 cloth, and range from that to such as will pass through a No. 2 cloth, those coarser than the latter number having been reduced to that size. This suggests the proper clothing of the reels, or rather of the scalping numbers, the flour numbers being practically arbitrary.

Two diagrams are here given; one for the separation of middlings reduced by rolls, and the other for the separation of middlings ground on buhrs. We will consider them in the order named. The first reel is clothed with Nos. 12, 6 and 4 cloths. Having adopted these numbers, the grinding must be accommodated to the scalping numbers. This grinding should be such as to require a portion of the stock which passes through the No. 4 cloth to be sent to the tailings. This is done by closing slides to the point where it is desirable to carry off such stock, the

other portion which passes through that number being sent to the dust middlings rolls. The amount of the stock passing through the No. 6 cloth which it is desirable to send to dust middlings, may be controlled by closing such slides under this cloth as the stock requires, and thus pass it to an open slide over that portion of the bottom conveyor which runs to the tail of the reel, and then to the dust middlings. This will rarely be desirable in a soft wheat mill. On the contrary, it might sometimes be necessary, in order to carry some of the stock passing through the No. 4 cloth into the reel below.

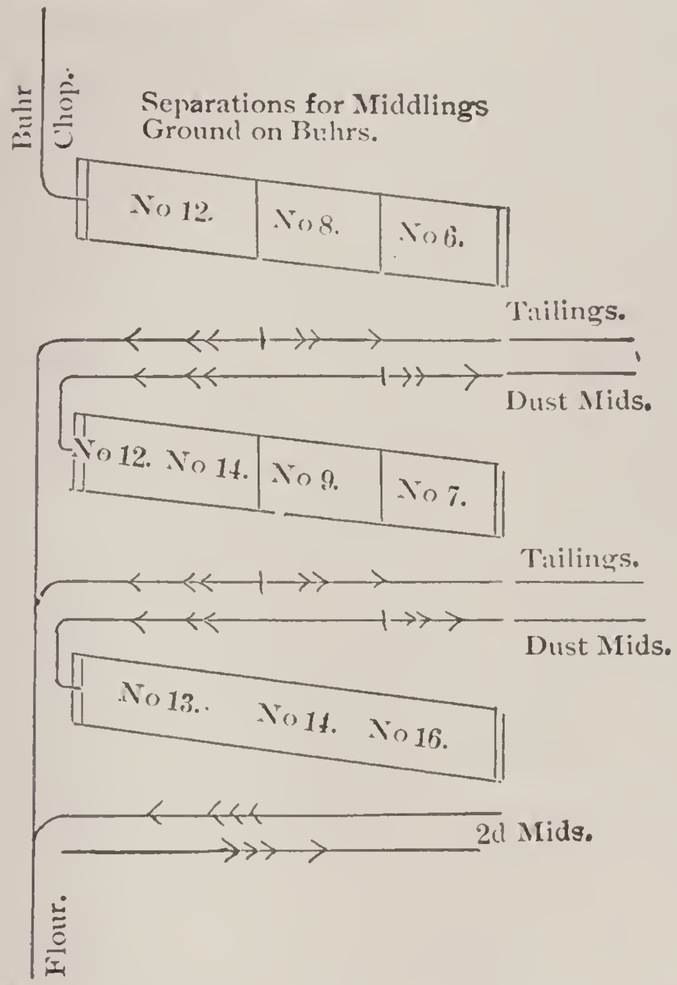
The next reel, which is clothed with Nos. 12, 14 and 8 cloths, is the one from which most of the flour will be taken. The tail of any inferior portion of the product of the No. 8 cloth will be sent to the dust middlings. The cut-off from the flour, or a proportion of the product of the scalping number, is sent to the reel below. The cut-off and tail of



this reel are second middlings, as may be a portion of the product of the No. 8 on the reel above. Thus it will be seen that none of the middlings coarser than those which will pass through a No. 8 cloth are second middlings, and any portion of such stock which the miller may choose may be sent to the dust middlings, but if his middlings are well purified and the separations on the upper reel properly manipulated, the proportion of such stock will be very small indeed. It may be well to call attention to the fact that from thirty to thirty-six inches grinding surface are necessary for such stock—a pair of 18-inch rolls, say, for the finer middlings and a 12-inch for the coarser—though 18-inch for each might be better. They should make about 250 revolutions per minute.

As to the separation of middlings ground on buhrs. The principal difference between one and the other is that the scalping numbers are finer, which fact makes it unnecessary to change the flour numbers. Another thing which may be noticed is that a large proportion of the stock

may be sent to the tailings and dust middlings. One reason for the scalping numbers being finer is that the stock can be reduced much more rapidly; that is, with fewer reductions, on buhrs than it can on rolls. This means as well that a larger proportion of the stock is reduced to fine particles. Another reason for these finer scalping numbers is that a larger proportion of the impurities are reduced in such a way as to endanger their being carried into the second middlings.



There are two sides to this question of the reduction of middlings by rolls or buhrs, and particularly so in small mills. One is that the rolls make cleaner flour, and the other is that they make less of it on the sized plant which a 100-barrel mill justifies. To put it in another form, it may be said that the rolls make better, or cleaner flour, while in the case mentioned the buhrs make a cheaper flour. To take another view of this matter, the equipment for the purification of middlings cannot be so complete on a small mill as on a large one; that is, the expense of the plant is not justified by the returns. For this reason the middlings will not be as well purified in a small mill as in a large one, and thus their purification by rolls would partially atone—as to the quality of the flour produced—for the difference in the quality of the original middlings. In the case of a larger mill, there is usually a more expensive proportional equipment of purifiers and sizing rolls, and for that reason it may be expected that there will be cleaner middlings, which are less liable to be injured on millstones than those of smaller mills. Thus it may be seen that this is a two sided question, whichever way it may be viewed.

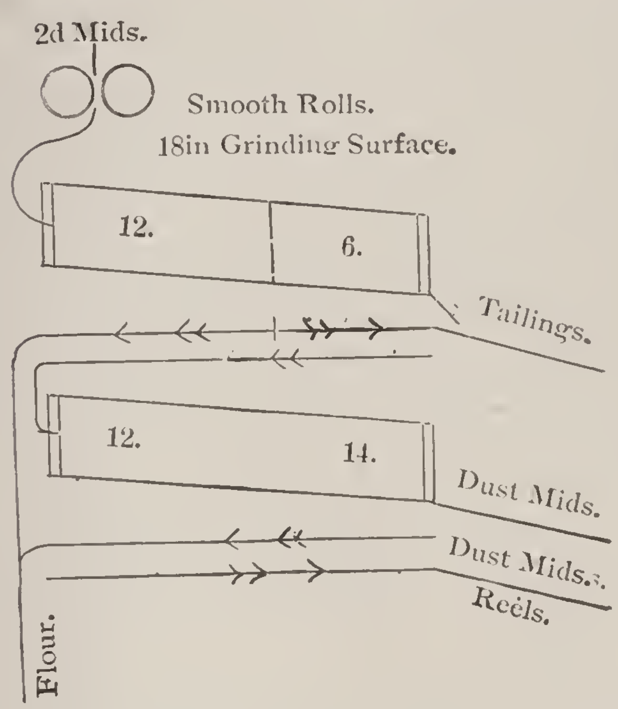
The quality of the second middlings may be estimated by considering their history. The quality of the first middlings, their reduction, and the means adopted for their bolting, determine the character of the second middlings. If the first is not right, the second cannot be right.

If we look into the history of the first middlings we may judge as to the excellence of the second middlings. If the first middlings are reasonably well purified—if they are properly reduced and intelligently separated subsequent to their reduction—the quality of the second middlings may be considered, other things being equal, as being good—better than the first. The first middlings having been reduced so that they will pass through a No. 6 cloth and finer, that portion which is coarse having been sent to the dust middlings or the reduction which follows the second middlings, it is clearly to be seen that, considering the means of purification of the first middlings and the plan of their reduction, the second middlings will be clean and bright; that is, that portion which went through a No. 6 cloth and finer, previous to its reduction as second middlings. Formerly the second middlings were purified on a separate system of machines, but if they are reduced on rolls in the manner previously indicated, further purification is hardly necessary; and, if they are reduced on buhrs, further purification by the ordinary means is hardly possible. Not but that a most excellent reduction may be made on buhrs, when sufficient previous preparation of the middlings is made, but it is to be remembered that where such a reduction is made, the middlings must have been reduced to a small size in anticipation of a millstone reduction, and their purification well cared for.

Thus it is to be seen that the second middlings are to be purified before they become second middlings, and that whatever purification they get after their reduction as first middlings is by the first reels, during a process of bolting. If the milling operations have been properly carried forward, there is no reason why the second middlings should not yield the best flour in the mill. Their quantity will usually be less where the reduction of the first middlings has been made by millstones, though this may be regulated somewhat by the character of the grinding. Where there is ample capacity for the reduction of the second middlings, it is well that the quantity for reduction by the machinery for such middlings be maintained equal to the convenient reduction capacity of that machinery, the reason for this being that the flour made with this end in view will be rounder and sharper, and in this way bear less evidence of haste in grinding. The middlings will be of better quality, as well as the flour. It is well that this feature be duly considered in the reduction of the middlings, in that middlings stock of good quality is the end sought in modern milling. For this reason it is fitting that such stock should

be afforded the best and most careful reduction, which never means rapid reduction.

The diagram for the reduction and separation of second middlings must be considered with reference to what has preceded it. While such an arrangement might be proper, in connection with previous directions, it might be altogether improper if applied in connection with different conditions. It is not possible to suggest arrangements of this kind which are suitable for the reduction and arrangement of a particular grade of stock, unless it be known what has gone before, and at the same time unless we anticipate what is to come.



The scalping cloth on the tail of the first reel is shown as being No. 6. With hard wheat this will be finer, and it might be that the results would be better if No. 7 cloth were used in the present instance, soft wheat being considered. But, if the grinding were not exact, it is quite possible that such an arrangement would result in loss. Then No. 6 cloth is used, and the conveyor under it is shown as running to the tail. Thus any portion of the material which passes through the No. 6 may be sent to the tailings. At the same time it is altogether probable that a larger portion of this material will be sent to the reel below. It is to be remembered that the No. 6 cloth is placed on the tail of the first reel, presuming that the second middlings will be reduced on rolls. While it is true that a portion of this stock has passed through the No. 6 cloth, little or none of it that is coarser being run to the second middlings, it is true that, after its reduction as such middlings by the smooth rolls, a portion of it will tail over a cloth through which it would have passed previous to its reduction. This is an element which is not true of millstone reduction. This scalper, in such an instance, would require to be much finer, say No. 9 or 10 cloth.

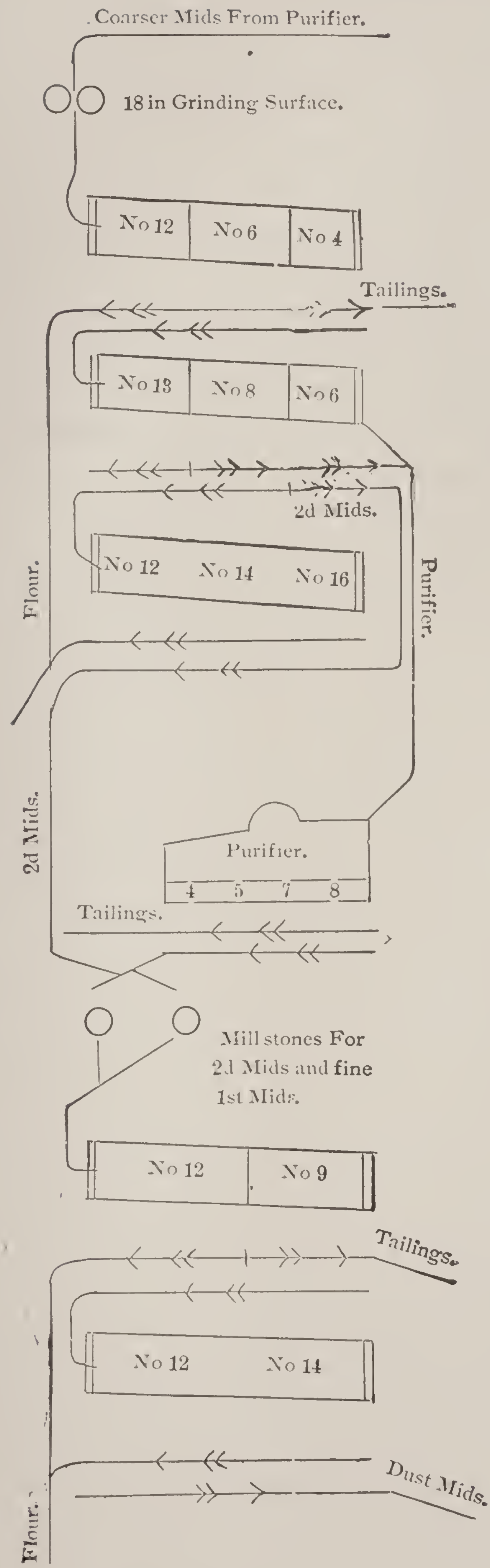
CHAPTER LVII.

ALTERNATIVE METHOD FOR THE REDUCTION OF MIDDLINGS.

The following is given as a suggestive sketch for the reduction and purification of middlings for a 100-barrel mill. The idea is to take the coarse middlings from the purifiers and treat them as first middlings, and the fine middlings from the first middlings, together with the middlings from the middlings—that is, the second—which two latter being run together are treated as second middlings. Or, to express it more clearly, the coarse first middlings are treated as first middlings and the fine first middlings and second middlings are run together and treated as second middlings. The plan contemplates the reduction of the coarser first middlings—those which tail over a No. 3 cloth—by rolls, and the reduction of the second middlings by millstones. Altogether, it is an arrangement which the writer likes very much.

On the first reel which takes the reduced stock from the rolls a little flour is taken off at the head, and the middlings are dusted over a No. 6 cloth and scalped over a No. 4. Any portion of this No. 4 may be sent to the tailings, and the desirable portion of the product thereof, together with that from the No. 6 cloth, is sent to the second reel, where more flour is taken off, and where a separation is made over a No. 6 cloth, which will allow a portion of the stock to go to the second middlings direct. Then most of the flour is taken off on the third reel, the material by the time it gets to that reel being in a splendid condition from which to take flour. As may be noticed, it was first scalped over No. 4 and then again over a No. 8 and a No. 6 cloth, in a way to allow any proportion of the latter which may not be suitable to be sent in another direction as second middlings. Thus it is plainly to be seen that we will get most excellent flour from this reduction, the quality of the flour, according to the scalping arrangements, being entirely under the control of the miller.

The quality of the second middlings is also controllable by the arrangements here outlined, it being possible to run stock which the miller does not care to purify, to the tailings. Again, on the second reel, the



stock intended for the purifier is thoroughly well dusted; and if the reduction by the smooth rolls be of the proper quality, if these rolls have the proper amount of grinding surface, which is here allowed them, and if their reduction be not too rapid, by setting the rolls too close, the middlings which are sent to the purifiers will be in most excellent condition to come out in splendid shape. The clothing of this purifier is indicated, the numbers being suggested by the clothing of the reels above. The middlings were dusted over a No. 8 cloth, and graded over a No. 4, hence the head number is 8, and, as it happens in this instance, the tail number is 4. It is a usual practice of the writer to make the tail number on the purifier one number coarser than the grading number on the reel or sieve, but, in this instance, it is desirable to keep up the stock as well as possible, and to run any stock which will pass over the No. 4 to the tailings. This serves a double purpose; first in the purity of the stock from the sieve action, and second, in keeping the sieve covered and thus getting the full benefit of the suction—a thing greatly desired in this instance.

Two pairs of millstones, both of which will not be necessary, thus allowing time for going over

the face occasionally, are shown in the diagram. As a matter of capacity, the difference in cost not being great, it is suggested that they be forty-eight inches in diameter. As to the quality of the stone, it should be close. The uniform draft of the furrows should be, say, six inches, more or less, depending on the speed, and with a large number of small lands and furrows, which should be faced, when necessary, with a diamond dresser, and never cracked, even with a diamond. They should be kept as smooth as possible. As before described, the millstones reduce the second middlings and the fine first middlings. The tail of the No. 9 cloth goes to the tailings and the product of the No. 12 to the second reel. The cut-off and tail of this reel go to the dust middlings, which product will be considered next.

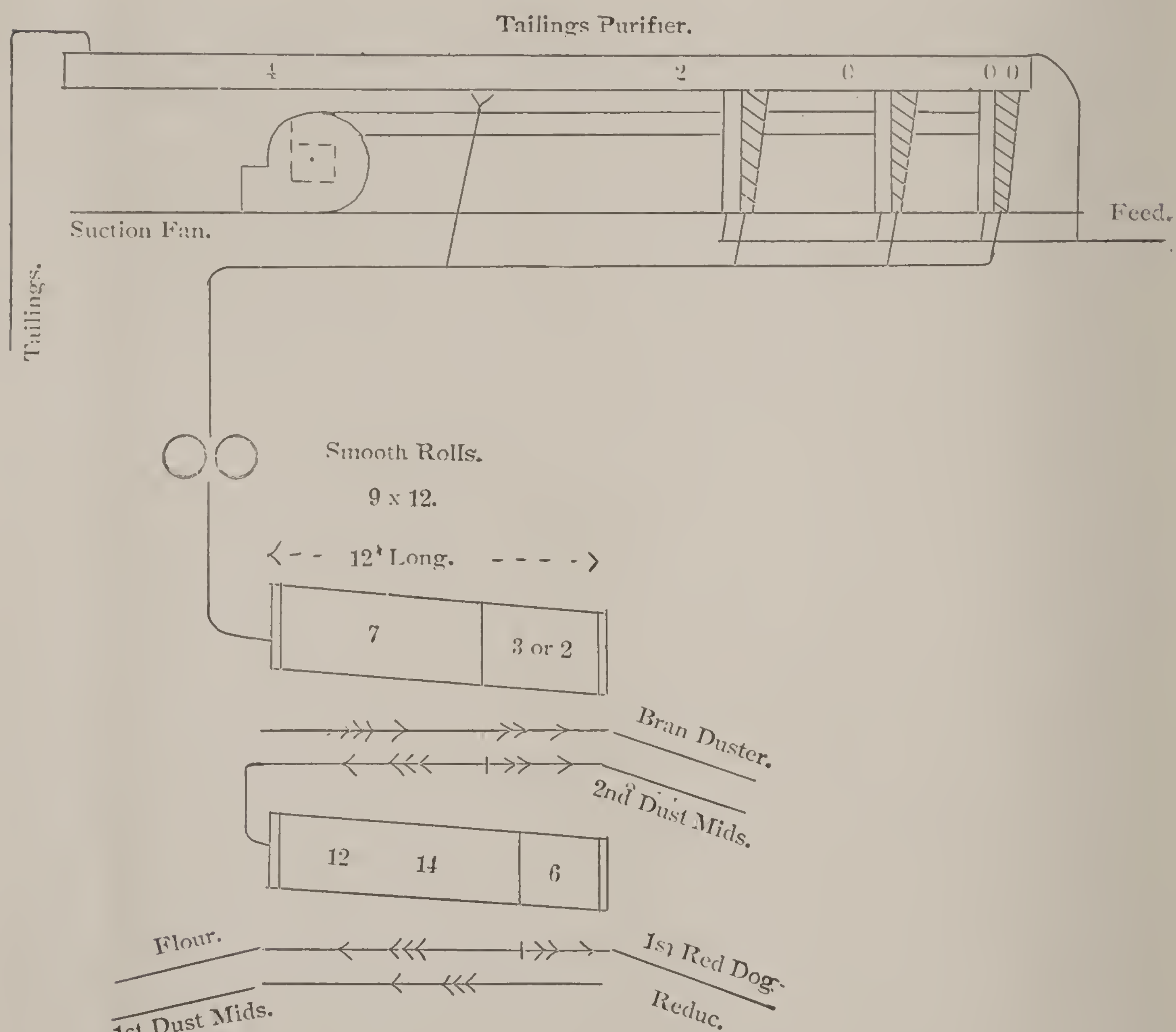
CHAPTER LVIII.

TAILINGS—PURIFICATION OF TAILINGS—TAILINGS ROLLS—SEPARATION OF THE TAILINGS PRODUCT.

If one were to begin at the tailings rolls hopper and trace back, he would find reason to feel disturbed at what he saw; in the first place, because of the richness of a part of the stock, and again on account of the poorness and contaminating qualities of other material. In the first instance, we have middlings which are not good enough for patent flour, and which we cannot but feel are too good for tailings. Then we have a large amount of fluffy stock which comes from the aspirators and the tails of the machines, which has just enough material in it to suggest nubs of middlings and white stock, so that we do not feel like running it into the red-dog. Here we have two extremes—stock which we can not run into the patent flour because it is hardly good enough, and material which we do not feel like running into the red-dog because it is hardly poor enough. Hence, and not logically, we run both together in the tailings rolls hopper. As we look at it in this way it seems a very strange and unreasonable proceeding. Of course we might separate the two in the reductions and boltings, but in a small mill we do not feel like keeping up all these divisions. One way out of this trouble has been outlined in the accompanying diagram, but it leaves another difficulty unsurmounted, and that is in the grinding of the stock. We have material as coarse as Nos. 0 and 00, and as fine as the product of a No. 4 cloth, going to a single pair of rolls. There is not a very large proportion of the extremes of the sizes indicated, but there is a tolerably large proportion of the coarse stock and a smaller proportion of the fine stock. A setting of the rolls which will properly reduce the latter will flatten the former. On the other hand, if the rolls be set to reduce the coarse stock properly, they will have very little influence on the finer material. In a large mill this problem is easily solved by grading the tailings. In a small mill this cannot be done, as the volume of stock is not large enough to justify the use of two pairs of rolls.

To return to the diagram: We have a sieve—the same kind which we

use in grading the middlings, only much smaller, say nineteen inches wide and ten feet long, which is clothed as indicated. To this is run all the tailings, the object being to get rid of the light, fluffy material which is a part of all the stock which goes into the tailings. This is done in two ways: First by the sieve action, which will carry a large volume of this stock over the tail or through the coarse cloth at the tail; and second, by the action of the aspirators, which have been described so many



times. This would be nothing more nor less than a tailings purifier. Any one who has never tried the experiment will be surprised at the large amount of red, fluffy stock which will pass over the tail of this machine. It will be in such volumes that, as it reaches the tail, one can take up large handfuls of it without a grain of middlings. The aspirators will take out the finer portion of this material, and the suction can be so regulated that the stock shown as going to the feed will be poor and thin—nothing more than bran which is equally red on both sides

This arrangement cannot be commended too highly. It is cheap, and can be made and set up by any ordinary mechanic. The top of the sieve should be left exposed so that it can be readily cleaned. This is best done by hand with the edge of a stiff leather belting. A cleaning once an hour, at most, is sufficient.

The separation of the reduced stock is about the same as we have shown once before. This stock is scalped on Nos. 7 and 3 cloth. The undesirable portion at or near the tail of the No. 7 is sent to the second dust middlings, or, if the stock at the tail of No. 3 should be extremely poor, it may be sent to the bran duster by closing slides under the tail of the top conveyor. The writer does not mean to say that he would run this material in with the bran to the duster, as he does not think that anything will be gained by the use of the bran duster on bran after it has left a centrifugal scalper. But we will consider this later. The cut-off from No. 7 and the desirable portion of the product of No. 4 is sent to the dust middlings reduction. By the way, it might be well to use a No. 2 instead of a No. 3 on this tail cloth, on soft wheat.

The better portion of the product of No. 7 goes to the reel below. The cut-off from the flour cloth and a part of the No. 6 goes to the first dust middlings. If this tailings purifier was not used, this could not be done; the product of the No. 6 would be entirely too red. The tail of No. 6 would be light and thin, having been scalped through a No. 7 before.

CHAPTER LIX.

DUST MIDDLINGS—PRODUCTION OF DUST MIDDLINGS—REDUCTION OF DUST MIDDLINGS—ALTERNATIVE METHODS FOR THE REDUCTION OF DUST MIDDLINGS.

During the years immediately succeeding the introduction of purifiers, very fine cloth was frequently used for dust middlings. The writer remembers to have seen the advertisement of a prominent American purifier in an English journal, wherein it was claimed they could purify middlings dusted over Nos. 14 and 16 cloths. About the same thing was often undertaken here. No. 12 was the common dusting cloth previous to the introduction of gradual reduction methods. At least this was so in the winter wheat section. No. 10 cloth was used in a few instances, though it can hardly be said that this was recognized as being the correct thing at that time. The dustings from the reels mentioned above were pretty hard looking stock; it was flat and feathery. With the introduction of the roller system, the middlings were dusted over a coarser cloth—No. 8 or 9 mostly—but the principal thing which distinguished this method of dusting from that of earlier years, was that it was done entirely before flour was taken off, rather than after, and the dusting reel was done away with. One thing which made this possible, aside from the fact that the dusting cloth is coarser, is that there are more middlings and less dust by the roller system of reduction. Again, the middlings by the latter method are coarser, and, because of their size and weight in the reel, facilitate the operation of dusting. To illustrate this difference, attention is called to the proportion of flour in the middlings as made by millstones. No. 0 middlings on soft wheat were commonly the coarsest legitimate middlings made, and there was a very large proportion of fine middlings. It is easy to remember that in the winter wheat section, No. 6 cloth was the ordinary grading number which separated the coarse from the fine middlings, and that in a mill which had three runs of buhrs grinding first middlings, there would be one for coarse and two for fine, and at a time when the sizings rolls were not used.

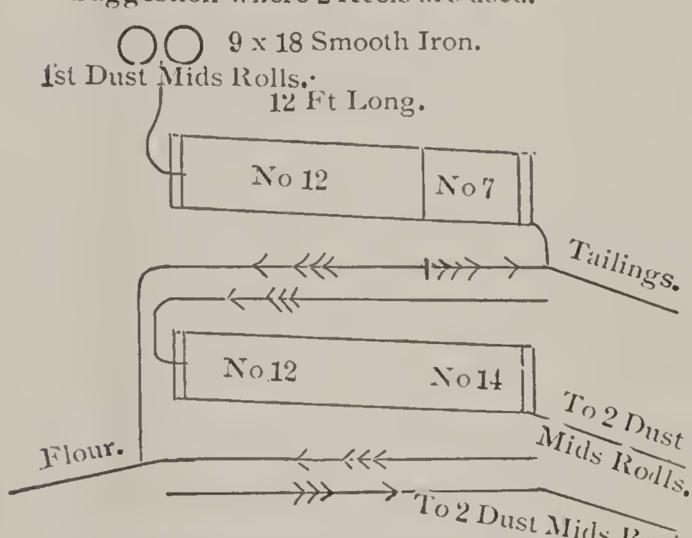
Now we know that No. 0000 middlings are by no means uncommon. However, No. 0000 stock is not legitimate middlings, but simply nubs of wheat largely covered with bran. But, in any event, the proportion of coarse middlings is very large. In the millstone mills which changed to rolls and maintained the old method of grading middlings—that is, from coarse to fine—they found that they had to change the No. 6 cloth and replace it with a No. 4, or even a No. 3, to give their fine machines anything to do.

This large proportion of coarse middlings has a great deal to do with the ease of dusting. With the reel covered with the No. 8 or No. 9 cloth, the separation of the flour from the middlings is soon made. The plan of using this coarse number is justified by the results in purification. At the same time that it is a better method with reference to the first middlings, it creates a new stock, a new classification, another grade of middlings—a stock which invites a different handling from any which we have yet considered in this 100-barrel mill. Dust middlings, as we will call this material, is that stock which is neither flour nor middlings which can be purified by the ordinary methods. It is material which will pass through the No. 8 and No. 9 cloth of the middlings scalper, but which will not pass through the flour cloth; that is, it is material which will pass through the Nos. 8 and 9 and tail over the Nos. 12 and 14.

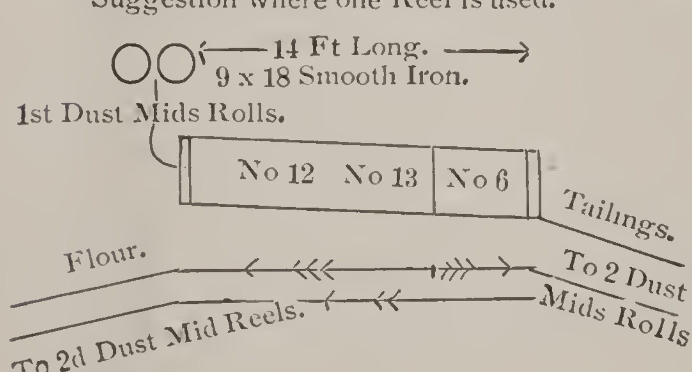
In the diagram for the reduction of the second middlings, it will be remembered that the better portion of the unreduced material—that is, the middlings from the second middlings—was run into the dust middlings. The stock mentioned is virtually third middlings. It is better in quality than the dust middlings proper, but in a mill of this size the quantity is too small to admit of distinct and separate reductions and separations. But these third middlings are of the same size as the dust middlings, and in other respects suited for reduction therewith, the only difference between the two stocks being that the latter has been submitted to a greater number of smooth roll reductions than the dust middlings, and therefore is not so susceptible to the action of the rolls; that is, the rolls do not have so much influence on the third middlings as on the other stock. It is well known that after material has been reduced a number of times without disintegration of any kind on smooth rolls, the latter reductions have less influence on it—reduce it less—than the first.

Strenuous efforts were made to purify the dust middlings stock during the earlier times of its development. In the first place, the purifiers had very little effect upon it, and that little was wastefully secured. With good grinding on the break stock this is a good material, and it is especially bright and clear in soft wheat mills. This stock has been ground on buhrs, but there is nothing half so good for its reduction as the smooth iron rolls. They, in connection with the reels which follow, are about all the purifiers needed, and are certainly all which would avail anything in the handling of these middlings. The flour made is next to the patent in quality. The diagrams offer two suggestions for the reduction and separation of this material. The first is with two reels, and the second with one. As to the first, the reels are only twelve feet long, which is sufficient, considering the size of the mill. Two such short reels present ample bolting surface and make the proper classifications. The first reel, it may be noticed, is clothed with No. 7 at the tail. To those who have not studied its stock and its reduction carefully, this number would appear illogical when it is remembered that the original stock all passed through No. 8 or 9 cloth. But one quality of this material is that it is inclined to be a little flat, and is made so by ever so careful a reduction. It does not necessarily cake, but is merely broad in the distinct granules. Again, this material, when passed through the Nos. 8 and 9 cloth, was assisted in its bolting by some very coarse material, and for that reason would, when by itself, tail over a cloth coarser than that through which it originally passed.

Suggestion where 2 Reels are used.



Suggestion where one Reel is used.



The quality of the tail of this reel can be regulated in the usual way, by closing or opening slides under that portion of the upper conveyor which runs to the tail. This arrangement admits of running any por-

tion of the product of the No. 7 to the tailings of the reel below. More time and space is taken in the description of the scalping cloths and the disposition of the stock derived from them than is devoted to the flour numbers, because it is so much more important. These flour numbers are influenced for good or bad by the arrangement of the scalpers and scalped product. The diagram is self-explanatory to such a degree as to need no further explanation.

CHAPTER LX.

REDUCTION AND SEPARATION OF SECOND DUST MIDDLINGS—ALTERNATIVE METHODS OF SEPARATION.

Before going to the consideration of the diagrams given, it is well to consider in short form, the effect which the reduction by rolls may have on stock which has reached this stage. It is particularly true of soft wheat that, after material has been reduced a certain number of times, an equal number of following reductions will not reduce the stock as much as the first; or, to express it more clearly, of four smooth roll reductions, the first two do proportionally a great deal more in the way of finishing the stock than do the last two. We find material going to the rolls for the reduction of the second dust middlings of a class which has been repeatedly treated on smooth rolls. While the writer does not believe in a class of reductions which cake the material to an appreciable extent, he does know that there is a certain flattening of the material, which makes it very difficult for roller reductions to handle. A millstone would do good work on this stock, and, if the grinding were not too low, would make good flour. For such stock the millstones should be smooth. We have a compensating device in the action of the centrifugal reel in rendering this material separable, and at the same time leaving it in a condition to be thoroughly susceptible to the influence of roller reductions. This is regarded as one of the legitimate uses of the centrifugal reel, its influence being such as to take advantage of the forms given the stock which will render the good separable from the bad. Another point favorable to the centrifugal reel at this stage of the operation, is that it will bolt the material which may be in such a condition as to be difficult of handling on the ordinary reel. It avoids the use of coarse cloth, brushes and wipers, and other instruments for evil. Two suggestions are given for the reduction and separation of this material—that is, the second dust middlings—the second of which is preferable, a centrifugal reel being used in connection with the smooth iron rolls. In Fig. 1, where an ordinary reel is used, Nos. 12 and 14 are used for the flour numbers, and No. 4 for the scalping number. The tail and the

inferior portion of the product of the No. 4 may be sent to the second red-dog reduction. The flour may go to the clear and the cut-off, and the better portion of the product of the No. 4 goes to the first red-dog reduction. The quality of the flour made at this operation will depend largely on the character of the reduction by the rolls. It is important that the material be reduced to, as nearly as possible, a uniform degree of fineness. For, if any portion of unreduced material gets through the rolls, the flour cannot but be gray and specky. The closing of slides will have very little effect on the flour numbers.

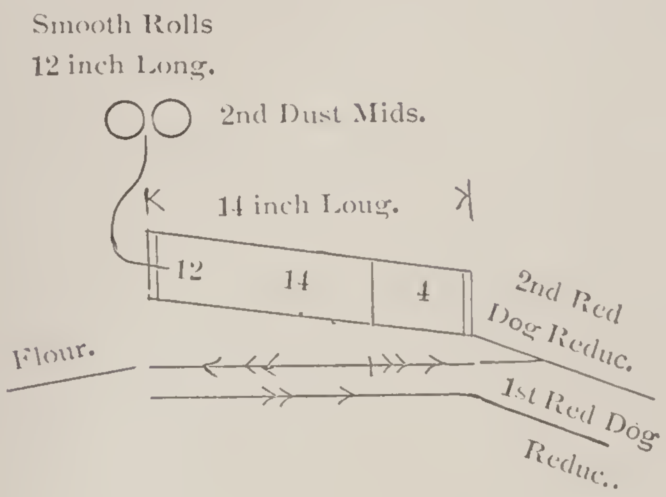


Fig. 1.

The second and preferred suggestion, as shown in Fig. 2, is arranged on the same general scheme as the first. Because of a centrifugal reel being used, the scalping number is finer, as well as the first flour number. With this plan, the stock going to the red-dog reduction will not be so rich or so large in volume as by the first. Consequently there need not be so much milling after the material has left this reel.

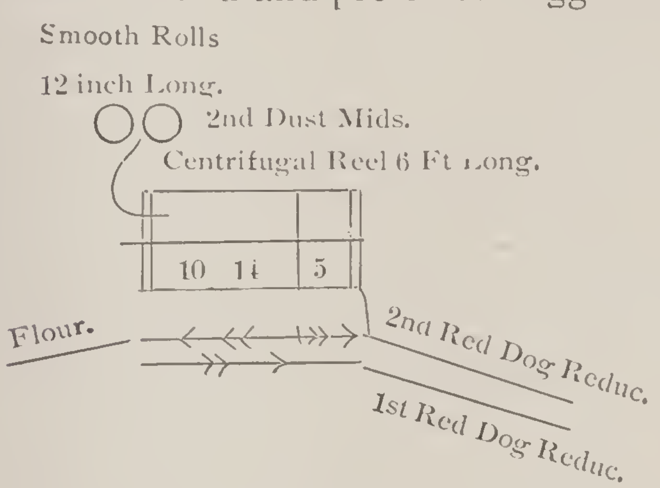
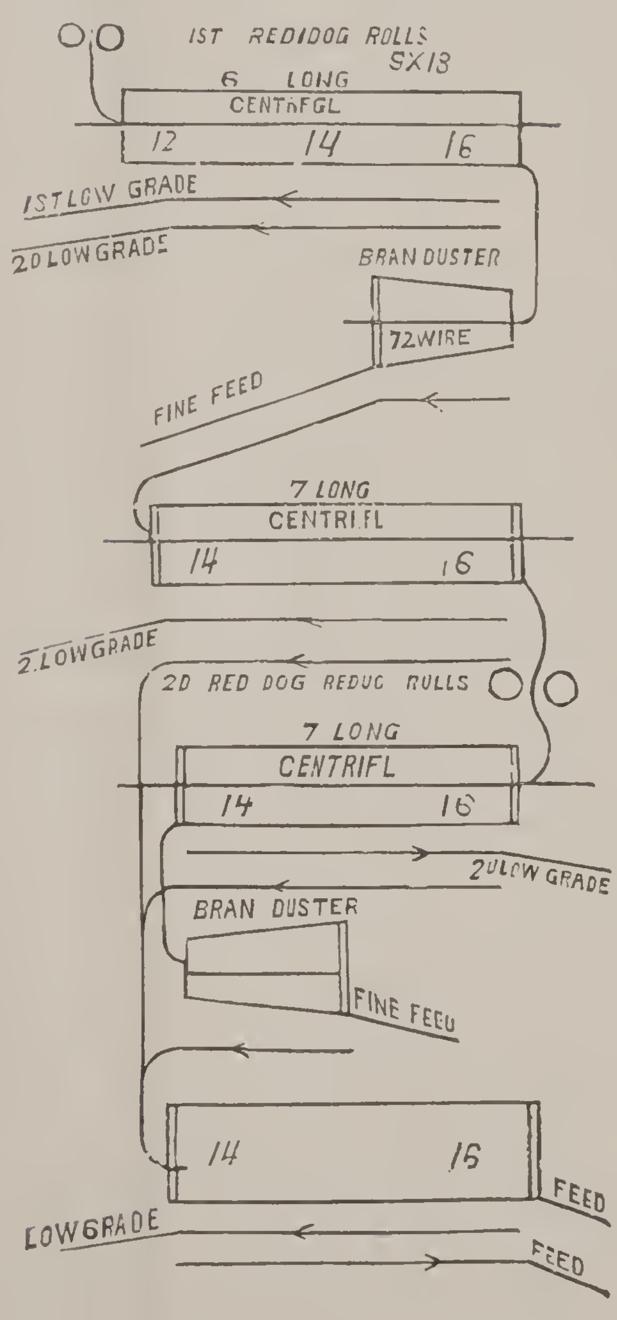


Fig. 2.

CHAPTER LXI.

RED-DOG REDUCTION BY SMOOTH ROLLS—DIAGRAM OF SEPARATION OF RED-DOG STOCK.

The reduction of red-dog stock by rolls is the next thing in order. It is nearly an endless piece of work. In some of the other diagrams which are to follow, millstone reductions will be shown, but for the purpose of making a showing for a roller method the following is given, and it will accomplish the work which it is intended to do.



Smooth rolls are natural purifiers. Their tendency is to reduce the flour stock, and to either flatten out the impurities in such a way as to render them separable from the flour, as is the case with the germ and fibrous and cellular structure of the wheat, or to leave other impurities intact—that is, whole—as may be in the case of bran, or other material of like character. We take all such material, excluding the bulk of the bran, run it together and call it red-dog, and then we take this same material which the rolls have failed to reduce before and send it to the red-dog rolls. Of course, they do it very little good. We have white, flat stock going to the feed pile. It is this condition of things which so frequently brings in a pair of buhrs at the tail end of the mill, and it is as disintegrators and grinders that these buhrs do their work. Red-dog flour is, or should be, made from the impurities extracted from other flour

stock, and in their nature the qualities which made them separable by roller reduction prevents them from being fully reduced by the red-dog rolls, however great may be the number of reductions. If this is true, it strikes the writer that the rolls themselves will not sufficiently reduce the red-dog material, except, perhaps, with an unusually and unjustifiably large and expensive plant. The writer has attempted to reduce red-dog with smooth rolls, and has employed as many as four reductions for such a purpose, though his faith in the ultimate result was never so great but that he had a millstone at the tail end. This was on soft wheat, the red dog from which is always more difficult of reduction than that from hard wheat.

Now, as a short and direct method of reducing the red-dog stock, it is suggested that, after its first reduction and separation in the manner indicated by the diagram, the tail of the reel be passed through a bran duster clothed with, say, No. 72 wire. Into this same duster would also go the stock from the other parts of the mill intended for the last reduction of the red-dog. The tail of the duster would be sent to the feed pile, while the product, after being bolted on the centrifugal reel, would have the coarser stock sent to the last reduction of the red-dog. Thus this material would have all the coarser bran stocks separated from it, all the fibre and white stock disintegrated and the flour removed therefrom, and, altogether, be in a favorable condition to be acted upon by the red-dog rolls. The product of these rolls, as indicated, is sent to a centrifugal reel, and the tail of that reel to a finely clothed bran duster, and finally to the feed.

Following is given the completed diagram of the 100-barrel mill which has been described in the foregoing chapters.

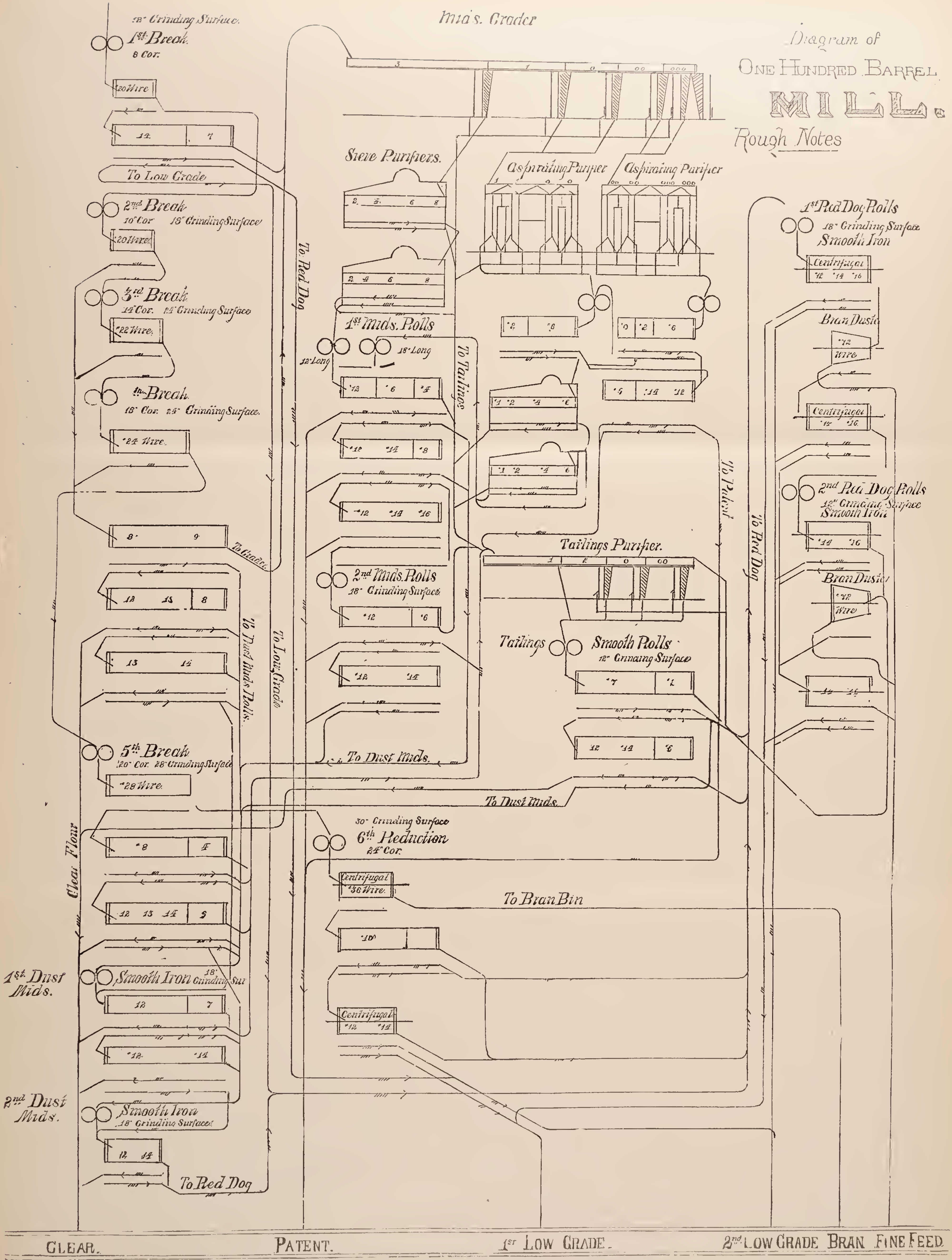


Diagram of
One Hundred Barrel
MILL.
Rough Notes
Mid's. Grader
18" Grinding Surface.
1st Break.
8 Cor.
20 Wire
To Low Grade
2nd Break
10 Cor 18" Grinding Surface
20 Wire
3rd Break.
14 Cor. 24" Grinding Surface
22 Wire.
4th Break.
16" Cor. 25" Grinding Surface.
24 Wire.
To Grader
To Red Dog
Sieve Purifiers.
Aspirating Purifier
Aspirating Purifier
1st Mids. Rolls
12" Long
18" Long
To Tailings
1st Red Dog Rolls
18" Grinding Surface
Smooth Iron
Centrifugal
Bran Duster
Wire
Centrifugal
2nd Red Dog Rolls
12" Grinding Surface
Smooth Iron
Bran Duster
Wire
To Patent
To Red Dog
Tailings Purifier.
2nd Mids. Rolls
18" Grinding Surface
To Dust Mids. Rolls.
To Low Grade
Tailings
Smooth Rolls
12" Grinding Surface
5th Break
20" Cor. 28" Grinding Surface
28 Wire.
To Dust Mids.
To Dust Mids.
30" Grinding Surface
6th Reduction
24 Cor.
Centrifugal
36 Wire.
To Bran Bin
Clear Flour
1st Dust Mids.
Smooth Iron 18" Grinding Sur
Centrifugal
2nd Dust Mids.
Smooth Iron
18" Grinding Surfaces
To Red Dog
CLEAR.
PATENT.
1st LOW GRADE.
2nd LOW GRADE
BRAN
FINE FEED

A SEVENTY BARREL MILL.

CHAPTER LXII.

WHEAT CLEANING FOR A 70-BARREL MILL—CAPACITY OF WHEAT CLEANING MACHINES—SEPARATION OF DUST AT THE WEIGH HOPPER—THE ROLLING SCREEN—ROLLING SCREEN AS A SEPARATOR—COCKLE SEPARATOR—SCOURING MACHINE.

Before considering the diagram of this 70-barrel mill, it will be well to say something definitely about the wheat cleaning. In a mill making seventy barrels of flour in twenty-four hours, using four and a half bushels of wheat to the barrel, there would be required 315 bushels of wheat during that time. This is sufficiently accurate for determining the amount of wheat cleaning machinery needed. It will be presumed that we do not care to run the wheat cleaning machinery all the time. Most millers prefer to clean enough wheat during the day to last all night. If the wheat cleaning machinery is to do all of its work in ten hours, the various machines would have to be selected on a basis of between thirty-one and thirty-two bushels per hour. As all machines are not numbered alike, it will be presumed that a selection would have to be made on a basis of between thirty-one and forty-five bushels an hour, or in that immediate range. It is desirable that the estimate be made as nearly as possible on the minimum capacity of the machines. If the calculation should show that forty bushels an hour were required, the writer would rather advise the use of a machine whose minimum capacity was forty-five bushels an hour than one whose maximum capacity was that amount.

As the wheat is taken into the mill, a good thing to do, as said before, is to have a suction so arranged as to take off the dust which may arise in discharging the wheat from the cars or wagons into the scale hopper. Where the scale hopper is located in the mill, as it nearly always is in small mills, as well as in many large ones, the dust arising from the wheat is sufficient to penetrate everything in the immediate vicinity. The arrangement for collecting the dust, or rather drawing off the material which may arise, need not be too elaborate; in fact, it should not be other than a very simple arrangement. In the event of any complications which might not be understood by those not used to machinery,

it would prejudice them unfavorably in their judgment as to the accuracy of the weighing apparatus of a mill which contains such complicated or unusual devices in immediate proximity to the scales. A simple galvanized iron funnel placed over the shute and connected with the suction fan, will do all that is desired at this stage of the process.

After discharging the wheat into the bins, we would arrange to have it pass through a rolling screen before going to the separator. This screen should be as long as convenient; eight feet would be the minimum length and eighteen the maximum. The extra length is desirable because of its scouring influence on the grain. This screen might be clothed with No. 12 wire for about five feet at one end and No. 6 wire for about three feet at the other end, the dirt which goes through the No. 12 wire going out one way, and the wheat that passes through the No. 6 the other. The tail of the No. 6 wire, consisting of dirt, straw, etc., would go out at the same end as the wheat, but should, of course, be kept separate. There should be a suction fan in connection with this rolling screen which would carry out all the natural dirt, and that which is the result of the scouring. Attention has before been called to the fact that, while the rolling screen does good work, it was discarded with the influx of new machinery—in the change from the older to the newer processes of milling. In order to emphasize the value of this machine, it is well to mention that they are used in Hungarian mills not only for the purpose of wheat cleaning, but for grading as well. In some of these mills, during the process of wheat cleaning, the wheat is graded into large and small wheat before going to the separators. The smaller the stream of wheat running to these screens the better will be the work of scouring. This is apparent when we consider that when only a small quantity of grain is in the reel, each grain will be more often in absolute contact with the screen, will be subjected to more friction than where there is a larger amount of wheat to be taken care of.

It was common to use the old rolling screen largely for the purpose of separating screenings without particular reference to the separation of straw and corn, and other large impurities, though the writer remembers, in a few instances, where a coarse piece of wire was used in the manner here described. He also remembers to have seen one such screen running in 1862 and 1863, which was placed in a room in a basement. There was a box or hopper which would hold four or five bushels, located immediately over it on the grinding floor. In this box wheat

was mixed. There were three spouts which entered it—one for amber, one for white, and another for long berried Mediterranean. At that time there was a premium of ten cents a bushel on white wheat, and from five to eight cents on amber. This wheat entered the screen, and the screenings which passed through the wire fell on the floor of the screen room, and as it filled up it was sacked from time to time and passed over a fanning mill, which, instead of being run by hand, was provided with a pulley that was run from another one attached to the projecting shaft from an elevator boot. From this screening the miller was able to get a little small wheat, which from time to time he ground into a separate grade of flour. The only other cleaning machine in the mill was a Eureka smutter.

In considering the wheat cleaning in this 70-barrel mill, we will start with the idea that we are to do the work well—as well as can be done with the ordinary machinery which is at hand. The separator, which may be any of the first-class machines now manufactured, and of the size indicated at the beginning of this chapter, will follow the rolling screen. The wheat, having passed through the latter machine, will be in most excellent condition to be cared for by the separator. A good portion of its work will have been done by the screen, and, when it comes to the treatment of the wheat by the separator, the miller will find that he can make much nicer distinctions and do much finer work than when the separator had all of the work to do. In sections of the country where there is cockle, it will be well to follow the separator with a cockle machine, and, while it is necessary that no machine should be crowded, it is imperative that the cockle machine, of all others, should be given only the proper amount of work to do. The loss where the other course is pursued is quite apparent. There are combinations which include a separator for dust, oats, chess, etc., constructed in combination with the cockle separator, and in a mill of this size where there is cockle with which to contend, it might be well to use such a machine.

Following this separation comes the scouring machine. To emphasize the matter of capacity, attention is again called to the fact that the scouring machines, as a part of the wheat cleaning machinery, are great sufferers from being overworked. In this mill the writer would use two scouring machines—the first one with beaters of a mild type, and the second a brush machine. A scouring machine will come about as near running itself as any machine in the mill. The makers have been com-

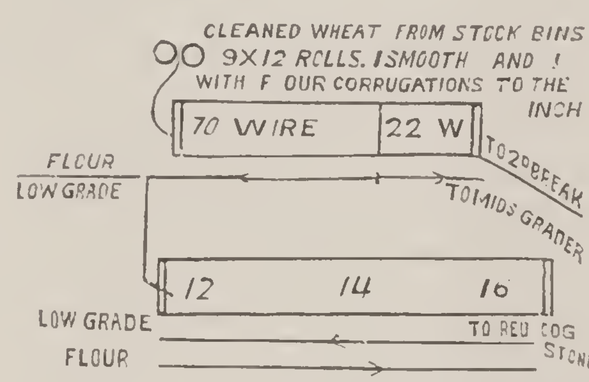
pelled to construct them with this idea. The fact that they will run with little care is no reason that they should be left to run themselves. Scouring machines are deserving of the same care, of the same judgment, and the exercise of the same skill, as any other machine in the mill. There are many millers who never use the lighter screw of the smutter or brush machine. They run along as they are started, without skillful care or attention. Very few millers consider it worth while to lay claim to skill in wheat cleaning; they are anxious to be considered experts in other departments in the mill, but are indifferent as to this.

CHAPTER LXIII.

FIRST BREAK FOR 70-BARREL MILL—DISC MACHINE—SECOND BREAK—THIRD AND FOURTH BREAKS.

The following cut shows the direction of the stock in the reductions and separations of this 70-barrel mill.

The No. 70 wire at the head of the first scalper, which reel may be six feet long in this instance, separates whatever flour and dust may be made by the wheat reduction. The middlings will go over the No. 22 wire and the reel will tail over to the second break in the usual manner. The No. 70 wire is equal to about No. 6 cloth, and the stock which goes through it will be subject for the low grade. The only objectionable feature in this arrangement is that the scourings on the No. 22 wire run in with the middlings. As far as the first break flour is concerned, the method of taking only that portion of the material which goes through the No. 70 wire into the flour reel, is preferable to sending the entire product, say of the No. 22 wire or coarser, as is the usual method, into that flour reel. The heavy, coarse middlings whip out the cloth and make it impossible to get even a fair quality of flour. The stock is so sharp that it cannot bolt clean, and then the friction of the middlings is not desirable. It tends to pulverizing, and to run what would otherwise be patent flour into the low grade. With our arrangement, we send the middlings which pass over the No. 70 wire and through the No. 22 wire to the grader, thus avoiding unusual and undue friction to these middlings.



The clothing of the scalper with No. 22 wire is unusual, No. 18 wire being the accepted clothing for that reel. But, as explained before, No. 18 wire equals No. 0000 silk, and No. 0000 middlings have no business in any mill unless there are especial provisions for taking care of them in a manner entirely separate and distinct from the other middlings. No. 22 wire is equal to No. 000 silk, which middlings are a little large for a

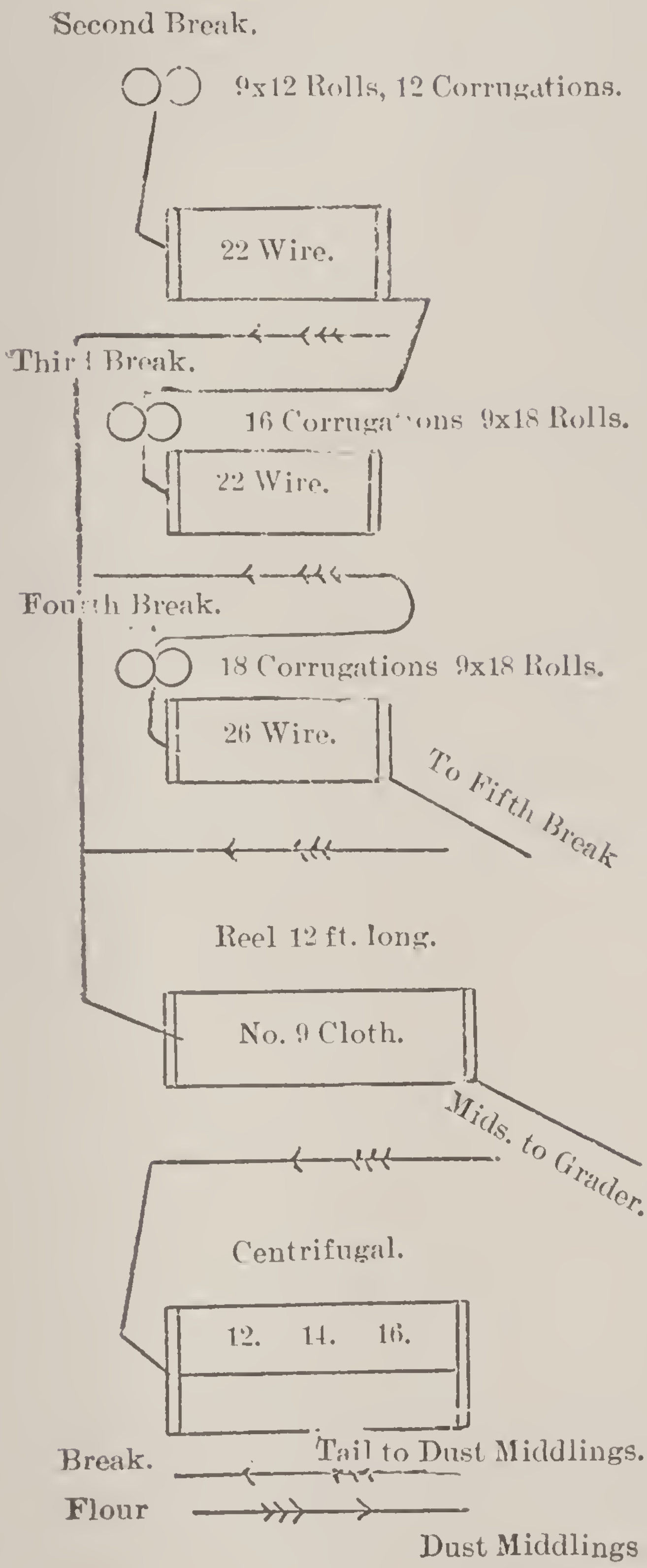
mill of this size. The product of the No. 70 wire, as shown, is rebolted on Nos. 12, 14 and 16 cloth. This cloth is so arranged that it will hardly be desirable to make a cut-off on a short reel, say one of ten feet in length. It is not unusual to clothe the first break scalper with a piece of No. 90 wire at the head, and then run the product into the red dog reel; but, as No. 90 wire is equal to No. 8 cloth, it is clear that the difference between the number on the low grade reel and a No. 8 cloth will escape reduction and thus go into the feed, which is wasteful.

The writer has never seen a first break by rolls which was as good or as satisfactory as that made by a disc mill, and he is surprised that these machines are not in more general use in large mills. The first break by rolls is far from satisfactory. While the idea is to split the wheat, there are a large number of grains which are not split in the proper way, and quite a proportion of grains which are mutilated. With the disc mills this latter proportion is largely reduced, though the proportion of first break flour is increased. The second and following breaks are much better when the wheat is split than when broken in an irregular way, as is so commonly the case with roller first breaks.

The ideal of gradual reduction would be something like this: Exact splitting of the wheat on the first break; the detaching of a large portion of the middlings on the second, and, perhaps, a slight breaking of the wheat; the detaching of a larger portion of middlings on the third and fourth breaks, without an absolute breaking of wheat or bran during such operations. On a six break mill, the fifth break is the beginning of the bran cleaning operations, and has in mind the scraping of the remaining flour and middlings from the bran. The sixth is the finishing operation. All this matter which pertains to the size of the bran is not practicable in regular milling, but the nearer we come to splitting the wheat on the first break, the smaller the proportion of broken and lacerated grains—grains which have the backs, ends and sides knocked off—the more nearly will we reach this ideal as to the size of the bran particles.

In the earlier descriptions of the gradual reduction method it will be remembered that the idea was conveyed that it was a gradual breaking system, and the name break rolls would imply the same at the present time. If the mere breaking of the wheat was the proper plan, it might be possible to cut it into small particles, and at the same time make a smaller proportion of flour than by doing the same with rolls. But such

is not the idea or practice in gradual reduction milling. After the first break it is more like a gradual scraping process than a gradual breaking one. The middlings are gradually scraped from the bran. It is done gradually in order to prevent the making of a large quantity of flour, or the pulverization of the bran. In the nature of things a certain proportion of flour will be made, a certain proportion of bran will be pulverized, and a certain other proportion of middlings will contain adhering portions of bran. We may consider the ideal of gradual reduction in order that we may estimate our failures, and, in doing so, we are necessarily influenced in the proper direction.



The accompanying cut is a diagram of the second, third and fourth breaks, together with the flour and middlings separation of the same.

The second break is given twelve corrugations. It may be remembered that, in the course of this work, ten corrugations have been recommended for this break, but that number was used where the mill was larger and more elaborate. For the reason that we do not care to make a very large proportion of large middlings here, the size of the corrugations will be reduced. As has been stated before, the size of the corrugations influences the size of the middlings. When the wheat is soft and the bran tough, it may be a proper thing to make a little closer reduction on the first and second breaks than would be in order under other circumstances. This was done for the purpose of being able to grind lighter—more open—on the third and fourth breaks, and, at the same time, be able to finish on the fifth

or sixth break. With soft wheat, if the effort be made to grind more closely on the third and fourth breaks than would be necessary if the grinding had been advanced on the first and second, the middlings would be soft and more difficult of purification than under more favorable circumstances. Furthermore, the close grinding of the third and fourth breaks will yield a larger proportion of soft flour than is desirable. It is hardly possible to make a very large proportion of break flour with the coarse corrugated rolls on the first and second breaks. Thus, under the circumstances mentioned, it is not at all out of place to grind a little close on these two breaks, and there may be lighter grinding on the third and fourth breaks, with the idea of making clean, bright middlings with a small proportion of break flour. According to the diagram given, the third break has No. 22 wire for the reel and sixteen corrugations for the roll, and the fourth eighteen corrugations for the roll and No. 26 wire for the reel. It is on these two breaks that the best break flour and middlings are made. The degree of excellence, as implied before, is dependent largely upon the previous preparation of the stock before going to these rolls, and is repeated here for the purpose of emphasis. But, this preparation having been made, there is an opportunity for nice discrimination and the exercise of judgment in the setting of these third and fourth break rolls.

CHAPTER LXIV.

DUSTING OF MIDDLINGS—EARLIER AND LATER METHODS OF MIDDLINGS DUSTING COMPARED—BOLTING OF BREAK FLOUR—USE OF CENTRIFUGALS FOR THE BOLTING OF BREAK FLOUR.

With the old stone methods only a part of the middlings to be purified were removed previous to the flour separation. Some of the coarser ones were taken off at the first and fine middlings were taken out from the last reel. It was not an uncommon thing for the middlings flour stock and all to pass into the first flour reel, and to take out flour at this stage of the process. On the tail of the reel was a scalper which separated a certain proportion of the coarse middlings, and, as said before, from the last flour reel was taken the fine middlings. This method is practiced to some extent in roller mills, but it is a custom which is becoming less common all the time. It is entirely possible to thoroughly dust the middlings from the breaks over a No. 9 cloth, when all of the middlings are run into that reel. If the coarser middlings were removed, there might be some difficulty in dusting the fine middlings over such a cloth when the wheat is soft, but with the larger middlings in the reel there can be no question as to the results.

Not only is it desirable to dust the middlings in this way on account of the middlings themselves, but on account of the quality of the break flour, and the quality of the flour from the dust of such middlings. As long as there are coarse particles in a reel from which it is intended to make flour, it may be set down as a fact that the flour product is not of as good quality as it might be under more favorable circumstances. For this reason all flour stock should be scalped of all coarse material before endeavoring to make a flour separation. There are two reasons for using a No. 9 cloth in case of a middlings break scalper. In the first place: No. 9 cloth is as fine as should be used for dusting middlings previous to purification. No. 8 cloth is in common use for this purpose and with reference to the size of the middlings. Another reason for using this No. 9 cloth is that it properly prepares the flour stock for bolting. This stock will bolt finer, cleaner flour than if it had come

through a cloth a degree coarser. Stock which would pass through a No. 9 cloth in the days of stone milling could hardly be bolted on a flour reel; it would be entirely too soft. For that reason coarser numbers were used for making a flour separation. The writer has in mind a case where the coarse middlings were dusted over a No. 6 cloth and then sent to the purifier, while the fine middlings were scalped a little from time to time as the stock passed from reel to reel, and the entire product of the fine middlings was dusted over a fine cloth.

A larger number of reels were used in the days of stone milling for the purpose of dusting the first, or what would now be called the break flour, than at the present time. There were two reasons for this: First, there was more flour; and second, the stock was softer, less sharp in character. It was not an uncommon thing to use six and eight reels in making a separation from this grade of stock on a 300-barrel mill. From a 500-barrel mill the flour separation after the middlings have been scalped is frequently made on two reels clothed with Nos. 12 and 14 cloth. While it may be desirable in such a mill to have more reels, it is nevertheless a fact that the above condition of things is by no means infrequent. In the case of a 70-barrel mill, scalping reels for the middlings should be about twelve feet long. The tail of that reel would go to the middlings reel and the product of the centrifugal immediately under it. It might be well to have an extra conveyor under this scalper, which lower conveyor would connect with the dust middlings roll. The reason for such an arrangement is this: If the flour stock should all be separated before the tail of the reel is reached, there would be clear middlings passing through the remaining portion of the tail of this reel, which middlings it would be desirable to send to the dust middlings, and which it would not be desirable to send to the flour reel. This flour reel, it will be noticed, is a centrifugal. A centrifugal is especially well adapted for bolting on a mill of this size. In the first place, if it be properly clothed, it will bolt the flour clean and bright, and it does it economically, in that the separation may be made on a single reel with a small expense for power and room. The separation of this stock can be made on one reel rather than two; it is all the better that it should be so done. After stock has passed through No. 9 cloth, very little opportunity remains for scalping, which would be the only reason for passing this stock through more than one reel. It will be noticed that this centrifugal is clothed with Nos. 12, 14 and 16 cloth. On an ordinary reel, as a general thing, the writer

does not care to use a cloth as fine as a No. 16, but, where a centrifugal is used, and especially at its tail, a No. 16 cloth means a little finer as to the quality and softness of the flour which passes through it than does the No. 12 at the head. The clothing of a reel in this way is not uncommon in Hungarian mills. Under ordinary circumstances it would be entirely possible to take flour the entire length of the reel, which would be, say, six feet long.

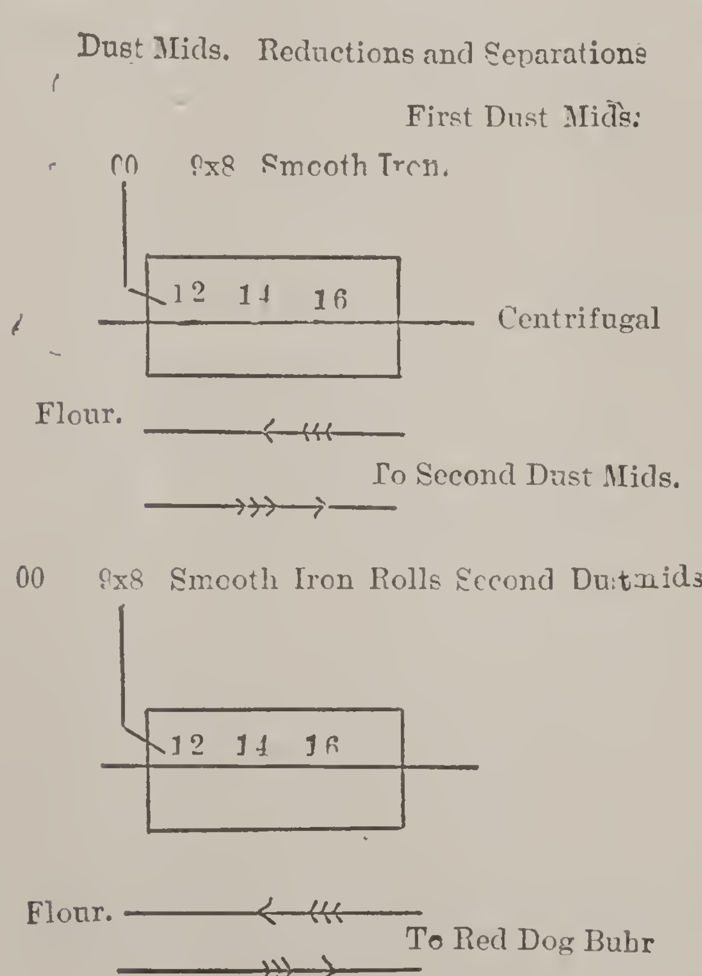
The flour which is made at this stage of the process, on the reel referred to, is of most excellent quality—a quality rarely understood or appreciated. The break flour is pulled down in quality, is depreciated by the lower products, by the product of the reductions which come immediately previous to the low grade flour. There is a large amount of false pride and ignorance displayed in regard to low grade flour. There is a disposition among millers to see how small a quantity of low grade flour they can pack. It is all right to strive to clean the wheat, to make reductions so that the flour will not be contaminated by low grade products, but when it comes to reducing and bolting the stock distinctively in a way to avoid the production of low grade flour on the low end of the mill, it is wrong and suicidal. It amounts to the destruction of a large quantity of what would otherwise be high grade flour. High grade flour can be made up to a certain point in every mill; in some mills the process can be carried farther than in others. Nevertheless, there is a limit. Whenever this limit is passed, it amounts to running low grade flour into the high grade packers. The thing to do in all milling operations is, in the first place, to make all the high grade flour possible, and when the limit of such possibility is reached, to work for the sole purpose of making all the low grade possible.

To return to the question of the break flour: It is well to say here that a miller will find it profitable to make a separate and distinct separation of the flour from the reel. If it does not show white and clean in the dough—does not make a most excellent quality of bread—the miller may set it down that there is something wrong in his bolting system. The doughing of the products of the various reels, when it is possible, is a practice which cannot be too highly recommended. It will give the miller an intimate knowledge of the various details and products of his bolting.

CHAPTER LXV.

REDUCTION OF DUST MIDDLINGS—SEPARATION OF REDUCED STOCK BY CENTRIFUGAL REELS.

It has been the custom in following the stock through the mill, as has been done several times in this work, to take up the middlings purification immediately subsequent to the treatment of the break flour reels, and to leave the dust middlings for consideration after the second middlings have been cared for. In this instance, as a variation and for convenience, we will take up the dust middlings first. It will be remembered that the last diagram had to do with the separation of the break flour from the middlings to be purified and the dust middlings. Here is a cut to which reference will be made in the course of this description.



During the times of stone milling there were, practically, no dust middlings. Anything which would not go through a No. 12 cloth was middlings proper, and was sent to the purifiers to be purified. In place of the dust middlings was what was known as dustings, a stock comparing, in a measure, with the cut-off from the last chop reel, and treated in the same way, which was frequently to rebolt and then to reduce on smooth rolls. It will be remembered by those who pursued this course in preference to returning to the head of the chest, that the flour from the dustings and returns, before being reduced, was of a very superior character, and the writer remembers in his own experi-

ence that this was a great surprise to him, expecting that the flour would be of an inferior character; for, if not so, why was this stock dustings and returns? The reason for the superiority of this flour was that the stock was sufficiently soft to bolt clean and white, and yet not so soft as to paste the reel. It was of inferior quality before being bolted by itself, for the reason that in the flour and dusting reels, which were clothed with Nos. 12 and 14 cloth, it had been associated with sharp material—middlings, in one instance, and in the other, flour which contained a large proportion of fine middlings. Being separated therefrom, the proportion of sharp material was reduced and it was then possible to make clean, bright flour. This is always the case.

The great principle in bolting—the controlling principle as to the quality of the flour—is to keep the stock as soft as possible, and have it bolt—to continue to reduce the proportion of sharp material as fast as the flour is taken out. It may be done by scalping up to a certain point; and then there is the residue of sharp material which is to be reduced as another means of making the stock soft and reducing the proportion of sharp material. This was the case in the bolting of the dustings and returns. All having passed through a No. 12 cloth, it was not possible to continue the scalping operation farther. After it had been floured over a No. 12 cloth it remained to send the tail of the reel to the smooth rolls for reduction, after which it was rebolted, and again a very good article of clear bakers' flour was secured.

To return to the dust middlings. It was immediately before the introduction of gradual reduction methods that millers of the better class determined that No. 12 cloth was too fine for dusting, and that Nos. 8, 9 or 10 were preferable. This idea secured its development in the gradual reduction milling, and the stock which was neither middlings to be purified nor flour—the stock which would pass through a No. 8 or 9 cloth, and which would not pass through a No. 12, was the dust middlings. Virtually, it was the product of a No. 9 cloth with the flour taken out, and in roller milling it is a most excellent product. Its quality is affected largely by the character of the grinding. If the grinding be too close, it will be specky and red, and if the grinding be too rapid, the stock will not only be specky and red, but flaky and flat as well, and difficult of reduction. It is particularly true of winter wheat stock that material which has been once reduced more rapidly than desirable is influenced for the worse for all future reductions; that, if it has been

flattened, it is next to impossible to keep a large proportion of this material from running into the low grade stock.

If the reduction rolls have been set too close at any time, if they have been run too fast, or if too much stock has passed to them, it will not only affect the break flour and the middlings to be purified, but conspicuously the dust middlings. This stock, as said before, should be white, granular and bright, and, if properly reduced and bolted, it will make flour which rates next to the patent in quality. It is a material which cannot be purified by the ordinary sieve and suction machines, but which can be purified to a very large extent by the smooth rolls, the potency of which as purifiers should never be lost sight of. In this instance their disposition is to reduce the flour particles and, in the case of proper handling, leave the impurities intact and in a state to be tailed over to the next reduction, or to the low grade stock. The dust middlings rolls on winter wheat should have about half the grinding capacity of the first break. However, in a mill of this size it is not possible, as rolls of such a size are not made, for which reason we select the smallest size, which is 9x8 smooth rolls; 6x8 or 6x9, or any other size which is in the market will do as well. It is a good fault, in this instance, to have a little more grinding surface than is absolutely needed, and it is ruinous to have less than enough. Where the dust middlings rolls are not of sufficient capacity to do their work well the first time, there is a loss which is in a degree irreparable. There is a certain amount of material which can hardly be saved from the red-dog stock. If one would stop to think of it, to think that this material is only in a slight degree removed from flour—has passed through a No. 9 cloth—it will be clear that it should not take three or four reductions to get this stock down to a condition where it may be properly run into the red-dog. Such a number of reductions is not at all infrequent for this purpose. If, instead of reducing this stock three or four times before reaching the red-dog, the same number of rolls be used to reduce it twice, it will be found that by the addition of this grinding surface the stock is thinner, the flour therefrom is better, and altogether the various products through and over the tails of the reels are better suited to the various classifications to which they belong.

In this mill the two reductions of the dust middlings on the 9x8 rolls will bring the stock to the red-dog in a condition well suited for such material.

After this extended generalization on dust middlings, and because of the clearness of the diagram, it is hardly necessary to go into a description of the run of the stock, or to account for the various dispositions of material which are there indicated. It will be noticed that centrifugal reels are used for caring for this stock. Reels six feet long are ample, and their clothing, as here indicated, is justified by what was said on this subject during the course of the last chapter.

CHAPTER LXVI.

PURIFICATION OF MIDDLINGS ON A 70-BARREL MILL—GRADING OF MIDDLINGS—SIZING AND SCALPING OF MIDDLINGS.

The purification of middlings on a small mill is a problem of more than ordinary difficulty. When we consider the expense and pains that have been brought to bear upon the production of middlings, when we consider that their production by corrugated rolls is the sole purpose of the gradual reduction of wheat, we can see how illogical, how unreasonable it is to neglect the middlings—how wrong it is to be careless of that which it has cost so much to produce. How often is it that we find the six reductions by corrugated rolls elaborately arranged and intelligently cared for in respect to these reductions themselves, and, following them, how often do we find exhibitions of indifference and carelessness? All of this goes to show that the introduction of the gradual reduction method into a mill has often been more a matter of impulse than reason and intelligence. The system is put in a mill because it has been put in other mills. It is used because it is a gradual reduction method. If the miller gives the idea, the purpose of his mill serious attention, he will realize, aside from the general commercial purpose of making money, that it is the making and purification of middlings upon which the success of his efforts as a miller and business man depends.

Now, say that the miller has his six reductions and the following reels, or, as in the case of our 70-barrel mill, the five reductions, and the means for separating the flour, the middlings and bran as produced by those rolls, say he has all this—say he has made the middlings—how utterly foolish, how disastrous must it be to his success, if he does not give proper consideration to and exercise a proper understanding in the care of those middlings. It is the key to his success as a miller. Having gone so far as the production of the middlings, there is no retreat, no backing down in his care for that grade of stock. It is here that success or failure stares him in the face. The value of his flour depends on its purity; the purity of the flour depends largely upon the purity of the middlings previous to reduction, and the purity of the middlings de-

pends upon the arrangement and successful operation of the ordinary purification devices.

In a small mill it is not commercially possible to go into the same number of divisions or classifications of stock. It is not possible to recognize a large number of differences which would, in a large plant, justify classifications for the purpose of distinct and separate treatment; but there are certain classifications which must be recognized, no matter how small the mill may be. If the middlings must be purified, there are certain things which must be done in order to accomplish, measurably, the ends of ordinary purification devices. First, there must be a grader, and, as to the number of grades, there can be no limitation without risk of failure. In fact, there is no reason why the number of grades should be curtailed. In this mill, as in the others which have been described, is a sieve grader, which, to all intents and purposes, is a machine which does the work of several purifiers. This fact is not generally appreciated. To consider the operation of sieve graders, it may be well to take a little space, especially as their use is so important, for economical reasons, for small mills. As has been described before, this grader is merely a sieve set on hickory springs which are about forty inches long. The throw to the sieve may be an inch, and the revolutions of the eccentric shaft 250 per minute. In a small mill of this size the sieve should be about twenty inches wide and sixteen feet long. There is no need of a conveyor, as the bottom of the sieve is usually covered with a light board.

The middlings are fed upon the sieve at the head, and they travel over rapidly in a light, thin stream. The motion of the sieve keeps the lighter particles on top. At times there will be more middlings made than at others, which means that the sieve will be covered heavier at one time than at another, in which event they will not be uniformly graded. Small middlings will be carried over beyond their own proper section when the stock is too heavy. A remedy for this difficulty would be cone pulleys on the driving and driven shaft. The normal speed, in case of necessity, might be greater or less than that mentioned. If the sieve was not sufficiently covered, there would be impurities which would crowd through the cloth. By changing the speed of the sieve according to the circumstances, this could be entirely remedied. If the sieve was covered too lightly, the speed could be relatively diminished. If there is too much on the sieve, the speed could be increased. Thus the cover-

ing would become lighter in proportion to the increase. With the grader under this control, the middlings would pass over the sieve in the proper manner, and the larger proportion of the impurities would float along on the top of the sieve. In this mill the grader is clothed as indicated below:

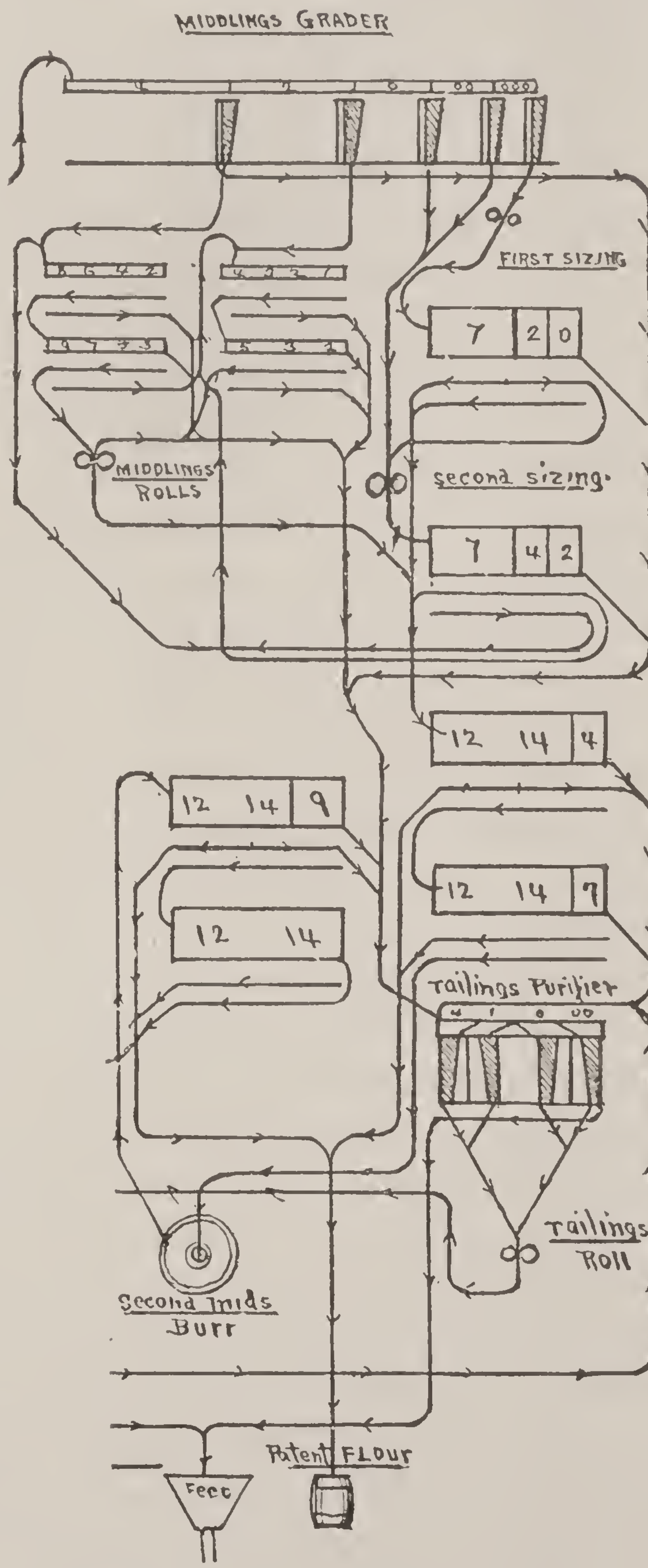
4 2 0 00 000

Under each section as here shown is an aspirator. There is a suction through the slats which takes out the light impurities and allows the middlings to pass through in the proper direction. The middlings which pass through the No. 4 cloth and into the aspirator will be in good shape for purification, but they will not be visibly affected by the aspirator, though it will take out quite a proportion of soft, fuzzy impurities. The middlings, after passing through it, wi l be in proper shape for the sieve purifier. The middlings which pass through the No. 2 cloth and through the aspirator will show, in a pronounced manner, the benefits of such an action, and the stock removed thereby will be light, thin bran. The stock which passes through the No. 0 cloth will be in most excellent condition after having been submitted to the action of the aspirator. A sieve purifier of the ordinary type will do this grade of stock very little good after having been so treated. As to the Nos. 00 and 000 middlings, the aspirator will do all for them that can be done previous to their gradual reduction by smooth rolls. As seen by the diagram, there will be five of these aspirators, as there are five grades of middlings which pass through them. Each one of these aspirators is connected with the same fan.

The suction is controlled by the valve, so that there need be no waste. There will be a tail over the sieve at the end, which will contain at times some coarse stock, more particularly such stock as has passed through holes in the scalpers. If arrangements be made for aspirating it, as it will contain a large volume of light impurities which float over the tail of the sieve, and which may readily be removed, the heavier stock can be sent to the third break.

Herewith is presented a cut showing the arrangement for the purification of middlings in our 70-barrel mill. The middlings purification for a small mill is a problem of more than ordinary difficulty, on account of the limited number of machines which, in the nature of things, must be used; and then, again, there are the sizings operations, which invite that the same care and skill be displayed, while the size of the plant does

not permit of a sufficiently large number of operations to do the most satisfactory work. The same thing applies to the final reduction of middlings. In fact, the general circumstances named are constantly to be met in the arrangement of a small mill.



In this diagram it will be noticed that we have for the purification of the middlings, first a grader, with the aspirators under each section, as before described; then four sieve purifiers of the ordinary type, two pairs of smooth rolls, one reel for each, and two reels for the dusting of the fine sizing stock; that is, the product of the No. 7 cloth. These smooth rolls and reels are as much a part of the purification system as the sieve purifier, and, according to modern ideas, the use of the smooth rolls as purifiers in this way is as essential to the success of the mill as the purifiers proper.

As to the system, it will be remembered that, in the description of the grader given, all of the middlings passed through the aspirators. The stock drawn out by these aspirators is tailings stock, such as is shown as going to the tailings purifier. The utility of this latter machine will be considered later. The stock from the two first sections of the grader, i. e., the material which passed through the Nos. 4 and 2 cloths, passes to two series of sieve purifiers, that from the No. 4 to one series, and that from the No.

2 to another. It will be remembered that the middlings tailed over a No. 9 cloth, which fixes the size of the finest middlings, and therefore fixes the number of cloth which will be used on the head of the first purifier. The number through which these middlings pass while on the grader determines the number for the body of the machine. The head number it will be seen is No. 8, which will allow the finest middlings to pass through; then there is the No. 6, representing an intermediate grade between the middlings scalping reel and the grader. The No. 4 cloth corresponds with the grader cloth. We make a short piece of tail cloth of No. 2, which is the number that comes next on the reel. It will be seen that no finish is taken off from the first machine, and that the bottom conveyor is arranged to run to the tailings. Thus any portion of the stock which passes through the No. 2 cloth may be sent to the tailings. The product of the upper conveyor may be largely influenced as to its appearance by the quality of the cut-off removed by the bottom conveyor. Considering that it is desirable to remove purifier middlings from the next machine, and as the middlings which go to this machine are cleaner and for that reason will pass through the cloth more freely, we use finer cloth on this machine. Thus it will be seen that No. 9 is the head number and No. 3 the tail number. The desirable portion of the product of the upper conveyor is finished middlings which is sent to the middlings rolls. The cut-off from this machine is sent to the next coarser grade of middlings. The quality of this cut-off is affected by the quality of the cut-off of the upper machine. It will be seen that the tail of this second machine is sent to the tailings.

The next grade of middlings passes through a No. 2 cloth, and the clothing of the machine for this grade is influenced, as stated before, by the number over which they pass before reaching this grading number and by the grading number itself. Four is the number used at the head of this second series of machines, and it is the number over which the middlings for this grade pass. No. 2 is the grading number, No. 3 the intermediate number, both of which may be noticed on the first purifier of this series. There is a small piece of No. 1 cloth on the tail of this machine. The cut-off from this first machine is regulated in the same manner as previously described for the first machine of the other series. The second machine for this grade of middlings is clothed on the same principle as described for the other finer grade of stock. The tail and cut-off from this machine go to the tailings. The middlings which pass

through the Nos. 0, 00 and 000 on the sieve grader do not pass to the sieve purifiers of the ordinary type. Where the aspirators of the pattern described are used, the middlings which pass through them will be in most excellent condition. All of the fine stock, bran, etc.. will have been removed.

We will consider the sizing of the middlings of the No. 000 grade first. They should pass through a pair of 9x12 rolls, and from thence into a reel clothed with Nos. 7, 2 and 0, as shown. The product of the No. 7 is indicated as going into the two reels below. The tail of the No. 0 goes to the tailings. The quality of these tailings will be regulated by the adjustment of the rolls. If the rolls be set too close, the tailings will be flat and rich; if they are too open, the stock will necessarily tail over in an unreduced condition. The product of the No. 2 cloth and the No. 0 pass to the second sizing rolls. The No. 000 middlings have been reduced to a size to correspond with the next finer grade, particularly that coming through the No. 0 cloth. This stock, together with that which comes through the Nos. 0 and 00, passes to the second sizing rolls, and from the rolls to the reels immediately below. The product of the No. 7 cloth goes into the two reels before described. The product of the No. 4 cloth of that reel, i. e., the second sizing reel, goes in with the No. 4 middlings of a corresponding grade, which are taken through the head of the middlings grader; or, to be more specific, they go to the first two purifiers which purify that grade of middlings. Then the middlings which pass through the No. 2 cloth of the second sizing reels go to the purifiers which take the corresponding grade of middlings from the grader. The tail of the No. 2 cloth is tailings.

Now, as to this sizings operation. It will be noticed that the middlings of the Nos. 0 and 00 grades are reduced gradually to grades corresponding to that of the middlings which come through the first two sections of the grader, but which middlings from the sizings do not pass to the grader, but rather directly to the purifiers of the two respective grades; that is, Nos. 4 and 2. Thus we have the middlings which originally pass through these numbers as being purified and sent to the middlings rolls, and the large middlings reduced and purified with and as a part of the same stock, the entire body of which passes to the middlings rolls to be purified.

CHAPTER LXVII.

CONTINUATION OF MIDDLINGS PURIFICATION FOR A 70-BARREL MILL—SIZING OF PURIFIED STOCK—FINAL REDUCTION OF MIDDLINGS BY ROLLS A SIZING PROCESS—SEPARATION OF REDUCED MIDDLINGS.

The first two and the finest of our five grades of middlings were graded through Nos. 4 and 2 cloth, and the last three and coarsest grades through Nos. 0, 00 and 000. The only purification which these latter grades received was the action of the grader and the aspirator which was placed under them. After this process of grading and aspirating these coarse middlings, they were submitted to the sizing rolls, which name is a misnomer, as they are nothing more nor less than smooth, gradual reduction rolls. They gradually reduce the coarse to fine middlings. Sizing, as it was originally understood, took a conglomerate quality of middlings and brought the larger to a size conforming to the smaller. However, this expression—that is, the sizing—carries its own meaning as applied to the present processes, and there is no serious reason for making a change. At all events, the three coarser grades of middlings which were taken from the grader were reduced to conform in size to the first two and finest grades of middlings; that is, the Nos. 0, 00 and 000 middlings were gradually reduced by the smooth rolls to Nos. 4 and 2 middlings, after which they were purified with the middlings of that grade.

In this arrangement the writer has endeavored to carry out what he regards as the true system of purification in a very small mill. After the middlings have passed through this process—after they have been treated on the sieve purifiers—we run them to a pair of smooth rolls. The coarsest middlings which we have there, are those which pass through a No. 3 cloth. The pair of rolls which reduce these middlings are nothing more nor less than sizing rolls, or another step in the way of gradual reduction rolls.

Before going on with the separation of this reduced stock, we will call attention to another grade of stock which was not treated or considered in the preceding chapter; that is, the material which passed through the

No. 7 cloth from the first and second sizing rolls reels, the product of which is always nice, fine middlings and a high grade of flour. This stock we run into the reel as indicated by the diagram, together with the stock of reduced middlings—the middlings of the Nos. 4 and 2 grade. Thus we have this reduced middlings stock and the product of the No. 7 cloth on the sizing rolls reel as running to the same reels for the purpose of separating the flour and middlings. This arrangement saves complication and accomplishes good results in a very direct way.

The product of the middlings rolls and the two sizing rolls reel passes first to a reel clothed with Nos. 12, 14 and 4 cloth. The product of the No. 12 and a part of the No. 14 cloth is flour. The cut-off from the No. 14 and the product of the No. 4 goes to the next reel below. The tail from the No. 4 cloth is tailings. The middlings rolls will produce quite a little stock which will tail over this reel, and properly so. The stock which passes to these reels should not be squeezed or mashed in a way to flatten into hard, wafer-like shapes, but should be treated the same as if it were being sized or broken. A well known foreign writer on milling topics has said that excessive pressure on rolls has a tendency to solidify rather than to separate or disintegrate the stock, which fact is a good thing to bear constantly in mind while setting smooth rolls.

If middlings could be made absolutely pure, only the final reduction machinery, without the following separating reels, would be necessary in the disposal of that grade of stock. Properly speaking, the final reductions of the middlings represent the last efforts in the direction of purification before the stock is put into barrels. It should be understood as such, and the handling of that machinery should be on the basis of such an idea. This view of the question of the final reduction of middlings settles the problem in the writer's mind as to the proper machinery for such a purpose.

The reduction of middlings is naturally and properly a gradual reduction, and is in a line with the continuation of the previous process of sizing. With a complete system of middlings purification it would be difficult to tell where the one began and the other left off. All would be a continued process of sizing and a constant taking off of flour and consequent purifications, until all the stock would be worked into flour of one grade or another. Under any circumstances there can not be, or should not be, a mashing or squeezing by the rolls, any more than there

should be with the millstones. The flaking and softening of the stock is no more desirable in one instance than is rasping, pulverizing and tearing in the other. Reduction by smooth rolls can not be properly grinding or mashing. It is a sizing process which takes the stock and reduces it to dimensions indicated by the appreciable difference of space, which should separate the rolls when doing their work. A good reduction is always contingent upon the possibility of purification, and is met by the conditions above indicated. The time will come when the line between the purification and reduction of middlings will be less clearly marked. It will be at a time when the full idea of the broad principles of gradual reduction are recognized and appreciated in detail.

Now if the middlings rolls be set carefully, not too closely, the stock which tails over the No. 4 cloth on the reels in question will be just the kind of stock which belongs to tailings of a poor quality, and the stock which goes to the next reel will bolt nicely. The product of the No. 7 cloth, which, by the way, might be No. 6 on soft wheat, will be second middlings of a most excellent quality. The effect of this whole operation on the purification of middlings, and in which process of purification the writer wishes to be always understood as including the smooth rolls and the reels which follow, has been to reduce the whole volume of middlings which originally pass through the grader, which were of a size from No. 4 to 000, to a grade which would pass through No. 7 cloth. Thus we have as passing to the second middlings buhr, as we call it, a grade of clean fine middlings which have been dusted over a No. 14 cloth and which will pass through a No. 7. These middlings will be fine and clean and bright. This system will be carrying out the idea of the gradual reduction and purification of middlings in a way that can not but be satisfactory from a milling and commercial standpoint. The middlings are of a size which can be readily and conveniently reduced on buhrs, which method is adopted in this mill.

The middlings, after having been ground in this way, pass to the reel shown on the diagram clothed with Nos. 12, 14 and 9 cloth. The product of the 12 and 14, for the most part, is patent flour. The cut-off from the No. 14 and the desirable portion of the No. 9 go to the reel below clothed with Nos. 12 and 14 cloth. The tail of the No. 9 will properly belong to the tailings, as will a certain proportion of the product of that cloth. It will be noticed that the conveyor under it is so arranged that any portion of it may be sent to the tailings. Thus the

quality of the stock which goes into the reel below is subject to the control of the miller. This is a very important arrangement, and one which should not be neglected. If a miller will take occasion to examine the product of the tail slides, he will often find red, foxy stock which should not go into the flour reel when it is possible to run it in another direction. This is just what is done in this instance. All or any part of the product of the No. 9 may go to the tailings.

Attention is called, as has been done many times before, to the clothing of the bottom reel as here shown and the reasons which lead thereto. Reels are ordinarily so clothed; that is, there may be Nos. 12 and 14 cloth on the upper reel and Nos. 12 and 14 cloth on the lower. A superficial method of reasoning might say that after having cut off flour or stock which passed through the No. 14 cloth, why is it to be supposed that flour of a good quality may be taken from a No. 12 cloth on a reel immediately under it, as according to the arrangement here shown? If No. 14 cloth was on the tail of the first reel, such reasoning would be correct in the conclusion that the product of the No. 12 cloth would be inferior to the product of the No. 14 cloth above. It is the scalping cloth on the tail of the first reel which affects the quality of a material in a way to produce flour of a high grade—flour of a quality superior to that which passed through the No. 14 cloth on the reel immediately above. The No. 9 cloth not only removes bran particles and red stock, but it reduces the proportion of sharp stock which would prevent proper bolting through any flour cloth. It is entirely possible to improve or to in other ways affect the product of flour on the lower reel, by regulating the softness of the stock which passes into that reel by the slides of the upper conveyor under the No. 9 cloth of the upper reel. The more stock that is run to the tailings from the tail of this upper conveyor, the softer will be the stock which goes into the lower reel, and, for that reason, the flour will be very much improved. The cut-off and tail of the lower reel go to the dust middlings. This stock might be called third middlings.

CHAPTER LXVIII.

TAILINGS OF THE SEVENTY-BARREL MILL—UNCERTAINTY OF THE VOLUME OF TAILINGS—COMPOSITION OF TAILINGS—END OF PURIFICATION METHOD—REDUCTION OF TAILINGS BY SMOOTH ROLLS—CHANGE IN DIFFERENTIAL MOTION FOR REDUCTION BY SMOOTH ROLLS—LIMIT OF POSSIBILITIES OF REDUCTION BY SMOOTH ROLLS.

We have said before that tailings was an uncertain product—might mean different things in different mills, might be rich in one and clean in another, and still be called tailings. As a matter of fact there should be, in mills of a size to justify it, a product which is intermediate between purified middlings and tailings. There are a few mills arranged on this basis, but it is not a common practice. Tailings necessarily contain some very low stock—oftentimes the larger portion of it might go to the feed. But mixed with and a part of it are bits of middlings and flattened stock, stock which contains very good flour. If the tailings be very poor, if the various products which go to make it up be uniformly thin and light, there cannot but be certain material from which this material was taken which is below the proper standard. Say, for instance, that the stock which comes from the middlings purifiers is very poor, thin and red. This condition would naturally imply that the middlings were not as well purified as they might be. In the case of the middlings, there is a certain amount of material which would hardly be regarded as middlings which were sufficiently well purified to go to the purified middlings bin, and the miller can not, with an easy conscience, send it in with the low stock which goes to the tailings, hence an intermediate product, as suggested above.

The volume of tailings, the proportion of such stock as compared with the other material of the mill, is affected largely by the care and skill exercised in the treatment of the sizing rolls, and in the arrangement and the clothing of the reels which follow. If the rolls be run too slow, there will be a certain amount of flat stock which will run over to the tailings. If such rolls be run too much open, there will also be material running in this direction. Waste, under this latter condition, is

less liable to occur than under the former. The miller is more liable to notice waste when the rolls are open than when they are too close. In one instance he will notice the middlings tailing over; in the other he will see the flat stock and the bran tailing over together. The middlings show for themselves; the flat stock may be mixed with the bran, for which reason it will not be readily perceptible. The clothing of the tail of the scalper from the sizing reel is important in affecting the volume of tailings, in that it may be too fine, and the miller, in his efforts to get the most of the middlings through the cloth, will crush too close and thus waste largely. Soft wheat will make a larger proportion of tailings than hard wheat. From the soft wheat the middlings are apt to be flattened in reduction. Where this occurs, the tailings rolls are sure to be surfeited.

A tailings purifier has been spoken of and indicated. A purifier has a place wherever impurities can be taken out in such quantities as to justify in a commercial sense their application to any grade of stock. As said before, the tailings are usually a conglomerate mass. They contain very poor stock, some of which belongs to the feed, and, at the same time, very fair stock, for which reason it is entirely justifiable to attempt to make a separation of the very poor and thoroughly good material. A purifier belongs as much to the clear flour, or to the low grade, for that matter, as to any other part of the mill. It is usually associated solely with the patent flour. As the purity of flour affects its value, it is well to make the effort to purify, as far as possible, all grades of stock.

The tailings of this mill are made up largely of the products of the aspirators which are placed under the graders. The richest stock which is to be found going into the tailings will be from the bottom conveyor of the last purifier, which operates on No. 2 middlings. The stock going to the tailings from the second sizing will be richer than that from the first. The stock from the reel which dusts the No. 7 sizings middlings and the stock from the middlings rolls will be a little flat and somewhat whiter than the other material. It need not be rich, however —will not be except in the case of very close grinding by the middlings rolls. The tailings from the second middlings buhr will be fine and red. The tailings purifier, as shown, is a sieve separated into four divisions, with an aspirator under each. It is graded 4, 2, 0, 00. The suction may be adjusted to suit each grade of stock, and in that way there need be no waste. The tail of the 00, coming, as it does, over a sieve, will be

very light stock, and in this instance there will be quite a volume of it. This statement is also true of the material which passes through the 0 and 00. The suction may operate quite actively on this material. An aspirator will do very little good on the No. 4 stock, though it will take out a certain amount of material. It will be white and flat, and if means were convenient it would possibly be well to send this material to the red-dog; if not, the suction should be extremely light. In any event, stock which passes through No. 4 cloth on this tailings purifier will not be a poor grade of material. This effort at the purification of the tailings is a very great benefit to that grade of stock. Not only is the quality of the flour improved by so doing, but the quality of the stock is of such a character that it may be more readily reduced by the smooth rolls than could be the case under other circumstances. The fine bran and soft stock which is taken out by the separator has a tendency to make a smooth roll reduction anything but complete and satisfactory. Not only is the volume of stock large, but it is of a spongy nature, which makes it difficult and unsatisfactory to handle. Another thing which the purification of these tailings would do would be to suggest further purification. The miller would look at it, see the change that is made, and it would immediately occur to his mind that other operations would be in order.

With this grade of stock, however, there is a point beyond which purification by ordinary means ceases to be effective. The purification by smooth rolls is, after a certain stage has been reached, the only effective and conclusive method. It was the habit, during the days of new process milling, to take tails from the purifiers, repurify them, and send the product back to the other purifiers. But then the sizing operations were not carried on to the same extent as now, and the large proportion of fine bran was not separated from the flour, as is now the case. The tailings from sizings rolls can not be purified beyond a certain point. One or two operations by a purifier will do about all that can be done for them, except, as said before, what may be done by the smooth rolls. A great mistake is made in the reduction of tailings by smooth rolls in setting the rolls too close, in mashing them too much. In this event there is a large proportion of flattened material which goes either into the feed or into the red-dog. If the rolls be carefully adjusted, the middlings will be broken and only a small proportion of the stock flat-

tened. Consequently only a small proportion of flour stock will go in other than the proper directions.

The tailings in this mill are reduced by smooth rolls, and, as shown, the separation is made by a centrifugal reel. The writer does not think that a centrifugal reel is the best reel to use in the separation of tailings stock. It is used here as an economical means of producing flour, not so much in the cost of the plant as in cost of the flour. Quite a difference may be made in the product of the tailings rolls by a change in the differential motion of such rolls. While the differential is excessive the flour will be more ragged; it will feel longer, will contain a larger proportion of deleterious material than when the reductions of such stock are made with a smaller proportion of differential. The action of the differential motion of smooth rolls is to elongate the stock. This quality or tendency is limited by the liability of the stock to break If a piece of dough were passed through the smooth rolls it would be flattened out, or elongated. The amount or proportion of elongation would be estimated by the differential motion of such rolls. The tendency of one roll to hold back and of the other to advance may be estimated by the excess in speed of one roll over another, and the elongating qualities on such a movement are exactly in proportion as the difference in speed. It is evident that the breaking action will predominate; that is, that there will be more breaking than elongation in flour stock. There can not be much elongation of middlings or brittle material of that kind. It will be broken. There is a limit to the elongating qualities of all material which goes on rolls, whether it be impurities or otherwise. Where the differential is excessive, it is apparent that a certain large proportion of the impurities would be broken and pulverized by the differential action of the rolls. As an illustration of possibilities, we will say that the motion of the rolls be integral; that is, that there be no difference in speed. There will be a compressing of the stock, and certain portions of it will be broken; there will be very little of the pulverizing action, either of legitimate flour or of impurities. The flour stock will be incidentally pulverized and broken, and the impurities, which are usually of a tougher character than the better material, will not be appreciably disturbed.

It is the tendency of all millers to want to pulverize or to make flour on most reductions, and especially the tailings and the lower grade rolls of this kind, and for this reason it may be expected that there will be a

certain amount of differential at all times for the reduction of this material. In fact it can hardly be expected, nor is it desirable that there be differential motion wherever smooth rolls are used. The disintegrating action of this movement is so gentle when the rolls are not set closely together that it can not but be desirable, though the amount of such differential may be varied according to the quality of material to be handled. With belt rolls it is a very simple matter to vary the movement, and it will be easy for any miller to demonstrate to his own satisfaction the proper motion to select in the reduction of tailings. There is a disposition among many who handle these rolls to set them very close, which is entirely wrong, principally because it does not accomplish the desired end. There is a lurking idea in the minds of many millers that the closer the rolls are set—the closer it is possible to set them and still keep the belt from slipping, the greater will be the amount of work done by such rolls. That is wrong.

There is a proper point in the setting of rolls, one which will accomplish more work than any other, and it is not the point where the greatest amount of power is consumed or where the rolls are set the tightest. It is where the stock is broken and not flattened. This is the greatest evil, the place where the greatest wrong is done to the stock in milling —this same close setting of the smooth rolls. It is a very simple matter to judge when rolls are doing their proper work. The stock, as it comes from them, feels as though it had been ground and not mashed. Not only will the amount of flour made by the proper setting of the rolls be greater, and not only will the proportion of pulverized impurities be less, but the amount of power used will be greatly less. A miller says to himself: "I have only a few pairs of smooth rolls. I have not enough. Therefore I must set these rolls very tight that I may hasten the operation of reduction." He does not do anything of the kind. He cakes and hardens the stock. He makes it impossible to reduce this stock on anything short of a millstone. The stock having been thus treated on one set of rolls, those following have very little effect in hastening the work of reduction.

The writer once heard a very forcible illustration of the reducing power of smooth rolls. It was by a Hungarian miller. He had been working in a mill where there were two pairs of smooth rolls, some three or four reels, four or five purifiers with adjustable sieves, and one or two pairs of millstones. All the work of the mill was done on this ma-

chinery. One or two reductions at a time were made on the rolls that were in the mill, they being adjusted for each class of material to be handled, while the middlings and bran were reduced in their proper order on the millstones. It was the habit of the head miller of this mill to reduce all of his middlings on stones, and the miller who related this said to him at one time: "Why do you not reduce your middlings on these smooth rolls?" Said he: "We do reduce them as far as we can. We reduce them to dunst middlings (fine middlings) on the smooth rolls, but we can not reduce them farther by such means." The miller said: "It is my watch to-night, and if I may, I will try;" and with the consent of his superior, he did try. There was an accumulation of some ten barrels of this stock which had been produced by the breaking down of the larger middlings. He commenced to run it through the rolls, having it carried there by the help, and from the rolls to the reels. He reduced very carefully and very gently, and got very nice flour. He had the middlings carried back to the rolls and passed through them again with the same result—very nice flour. The third and fourth time was this repeated. Then he had about four barrels of stock remaining. After this the smooth rolls were almost inoperative. The stock kept going around and around without producing flour. He had been very careful; he had reduced the material very gently, only a little at a time, yet after four or five reductions on middlings which had passed through a No. 6 cloth, say, very little flour could be made.

To the writer this illustration meant a great deal. It showed or rather confirmed his belief that a complete corrugated and smooth roller mill is not quite the thing. It is hardly possible to completely reduce the product of the corrugated rolls with the smooth rolls. These rolls will go only so far, however carefully they may be handled, and no farther. There will be a certain amount of stock of most excellent character which is tailing over to the red-dog, and if the red-dog rolls be smooth iron, they will be tailing over the feed. In the case referred to, the miller said that after he had reduced the stock five or six times or more and found that little or nothing was being done on the last two or three reductions, he had it carried to the millstones and there reduced. As the material had been scalped repeatedly during the process of this reduction by smooth rolls, it was well purified and was for this reason in good condition to be handled by the millstones. It made most excellent flour, of a very high grade. After all, the use of the smooth rolls

in this way was not without its beneficial results. Smooth rolls, properly used, are always purifiers. In behalf of the millstone idea for the purpose of reducing certain grades of stock in a roller mill, we may call to mind the fact that more millstones are used by Hungarian millers in proportion to the amount of flour made, than by the best American millers. Millstones are more necessary in aiding in the reducing of soft than of hard wheat.

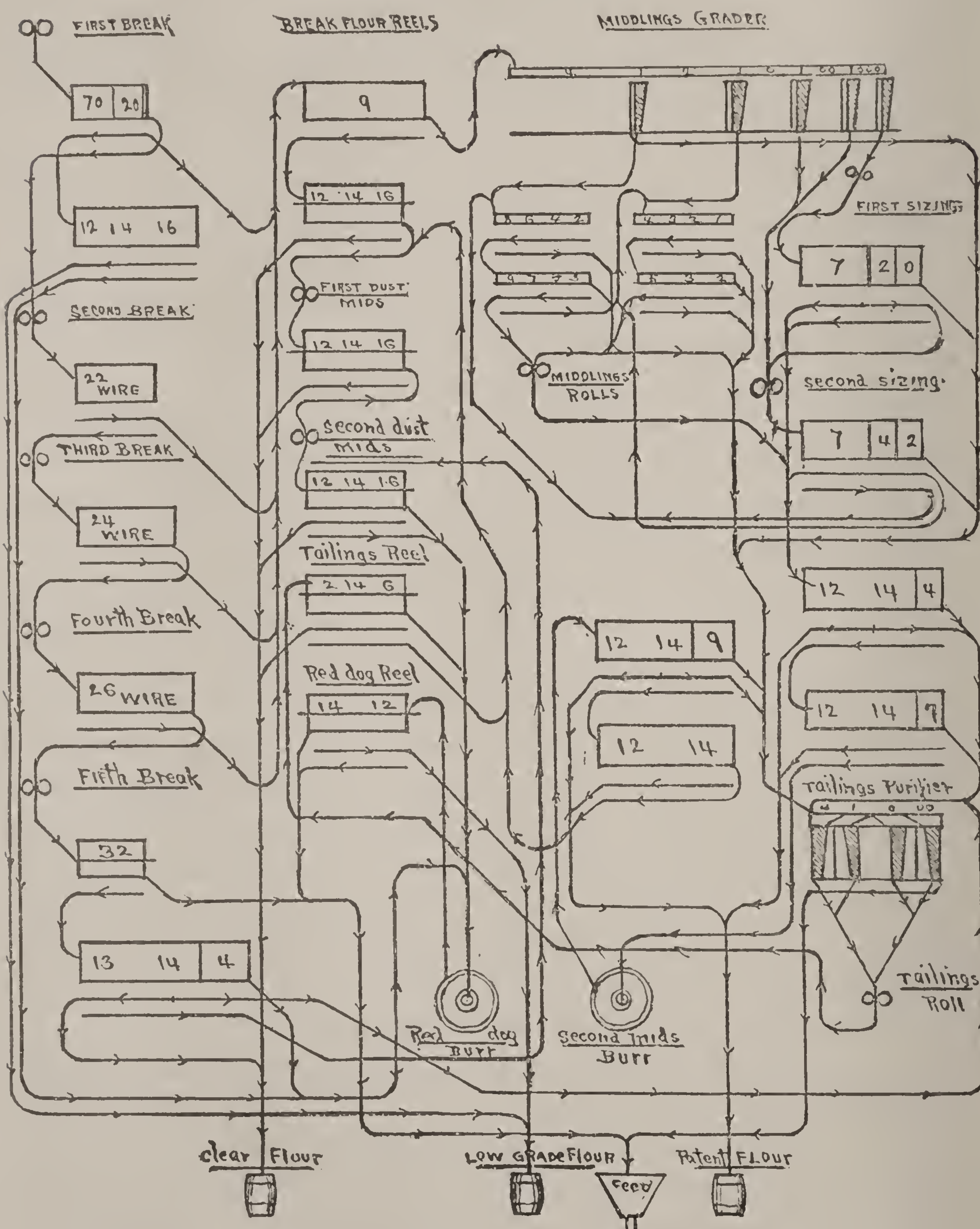
CHAPTER LXIX.

COMPLETION OF SEVENTY-BARREL MILL DIAGRAM—LIST OF MACHINERY USED—GENERAL VIEW OF SEVENTY-BARREL MILL DIAGRAM.

The completed diagram of the 70-barrel mill is here given. By looking at it, it will be seen that we have the following machinery, aside from that used in cleaning the wheat: Five pairs of corrugated rolls, six pairs of smooth rolls, two pairs of millstones, five scalpers, three short reels, five 14-foot reels, five centrifugals, one grader, four small purifiers, and one aspirating purifier. This may be slightly more than the machinery ordinarily used in a 70-barrel mill. This is intended to be a mill which will make money when competing with others in the general market. It is not a frontier arrangement, or a mill which has a local trade to depend upon, without competition from larger mills. In sections where there are no roller mills, a cheap mill, an incomplete mill, will pay about as well as anything. In many places a stone mill will do the work of making money. In sections of the country where a mill has a local trade which is not interfered with by other mills, it is not necessary that the most complete and elaborate diagram be followed. But for a mill which is intended to enter into the general market, for one which must compete in the east and elsewhere with the larger and more complete mills, it is necessary that particular attention be paid to the cost and quality of the product. There is only one weak point, that is, materially weak, in this mill, and that is in the use of only five reductions. Six would put it on a better footing.

The separation and reduction of the dust middlings and other soft stock, including the break flour, is in a very good condition, and will bring about good results. The purification of the middlings is cared for with some conside:able pains. It is recognized that in a mill never so small it is always important that the product of middlings be purified; that in any gradual reduction mill, middlings making and middlings purification is the general purpose, and if one neglects to purify the middlings, it is clear that he might just as well have neglected to make them. After going to the expense and pains of making middlings, they

should be well purified, otherwise it is not necessary to go to that pains and expense. The same thing is true of the reduction of the middlings. The tailings are cared for more elaborately than is common, but the



pains and expense will certainly justify the result. The attempt is made to separate a part of the feed from this product previous to the reduction of the stock, thus materially benefiting the quality of the break flour.

To take a general view of the details of the diagram, these things may be noticed: In the first place, three separations are made on the first break scalper—first the low grade flour and low grade stock through the head of the reel from the body of the stock; next the middlings from the tail stock, which includes the separation of the tail from that which has gone through the reel. These make the three separations. We next separate the low grade flour from the low grade stock which is to be reduced, then we take the product of the second, third and fourth breaks, and separate the flour and dust middlings stock from the middlings which go to the grader. Next we separate the flour from the dust middlings. The tail of the scalper of the four middle breaks goes to the middlings grader, where the middlings are graded into five different grades, the 4 and 2 grades going to separate purifiers, and the 0 and 00 grades going to one set of smooth rolls and the 000 grade to another. The 000, the 00 and the 0 grades are reduced gradually until the middlings correspond to the 4 and 2 grades, this reduction being accomplished by the means of smooth iron rolls. After they have been thus reduced they are purified with the middlings of that grade, all of which stock runs to another set of middlings reduction rolls, which brings the entire product down to a fine grade of very pure middlings, which may be reduced on a millstone and produce most excellent flour. All grades of these middlings have been purified so carefully that the flour made from the various reductions is suitable for patent flour stock. The larger bulk of the patent flour will come from the middlings reduction stone, which is intended to make the larger volume of the patent flour. The middlings which are taken from the reels which handle this millstone stock are sent to the dust middlings. After having been reduced by the millstones, this stock is again in a condition to be well handled by rolls, and it is submitted to two reductions by the smooth rolls. Any part of the stock which will not go through the flour cloth is sent to the tailings, where it receives an additional reduction. The stock from the dust middlings reductions is separated on centrifugal reels, as is also the stock from the tailings rolls. The tail of the second dust middlings and that from the tailings rolls reel, together with various other stocks of low grade character, run into the red-dog bin, which stock is again in a condition to be reduced by the millstones. It is hardly possible to reduce the red-dog product of smooth iron rolls on smooth iron rolls. It is the next thing to impossible, and as a natural consequence a millstone is

used for this purpose—not but that the smooth rolls would make better flour, what there was of it, but it would be small in quantity unless agitators or other mixing machines were used. At another time it was described how this stock might be reduced on smooth iron rolls by the use of agitators. While the millstone flour from the red-dog is not of so high a quality as that from rolls, it is much larger in quantity, which will more than compensate for the difference.

A FIFTY BARREL MILL.

CHAPTER LXX.

A 50-BARREL MILL—MACHINERY FOR 50-BARREL MILL—WHEAT CLEANING—CAPACITY OF WHEAT CLEANERS—MAGNETS—INFLUENCE OF WHEAT CLEANING ON YIELDS—SCOURING MACHINES.

A 50-barrel mill is about as small as a gradual reduction mill can be made. At the same time, with the machinery now at hand, such as is now made at various manufactories, it is entirely possible to make such a mill and properly proportion it for reduction machinery. The rolls must necessarily be shorter, the scalpers and reels shorter, and the purifiers smaller. It is not long since the smallest rolls made were 9x18 inches, and he who desired to build a smaller mill than one in which a 9x18 roll would naturally take a division of stock, was forced to so divide his stock as to have enough for that roll to do, and, in the same measure, reduce the number of his reductions. At such a time, three and four break mills were more common than they are now, and many grades of stock had to be run together which would better have been separated. Now we can get a pair of rolls, smooth or corrugated, from 7 to 30 inches in length. Their small size renders it possible to make the smaller classifications on a small mill and carry out the true principles and ideas of gradual reduction. In making a mill as small as the one here under consideration, it will not be attempted to make a diagram which is as elaborate as to separations and classifications of stock as upon a larger plant. While it is mechanically possible, the scheme is not regarded as commercially feasible. A diagram will be given of a mill which will make most beautiful flour and make it cheaply. The matter of yield will not be lost sight of any more in a small mill than in a large one.

As to the cleaning machinery: In the first place we will make provision for taking out a certain amount of dust from the head of the first wheat elevator, whence the wheat will run to a rolling screen clothed with square wire—wire with square edges rather than round surfaces. The reel should be about 12 feet long, for the purpose of getting the full benefit of the scouring action. The same fan which connects with

this rolling screen might also connect with the head of the wheat elevator for the purpose of carrying out dust. Three-fourths of the reel might be clothed with No. 12 wire, which would take out a certain proportion of the screenings and other light, fine stock, and the other one-fourth of the reel would be clothed with No. 6 wire, through which the wheat would pass, and over the tail of which would go the grains of corn and bits of straw and other coarser impurities. In the natural course of things the cleaning machinery for this mill would have to take care of about nine or ten bushels an hour, but as in such mills it is not always desirable or possible to run the cleaning machinery all the time, it would be well to select sizes of separators and scouring machinery which would clean, say, twice that much stock.

It may be noticed by an examination of the catalogues of the makers of various wheat cleaning machines that the second size which they make is the one adapted for this capacity; that is, twenty to thirty bushels an hour. The smallest size is intended to take care of ten to fifteen bushels an hour. Now while it is true that most mills work their cleaning machinery in excess of its maximum capacity, it is also true that they will do better work when operated to their minimum capacity only, and in this mill this would be advised. In some sections of the country it is necessary to use cockle machines. In such instances a combined cockle machine and separator may be used to follow the rolling screen. It might be well to mention, however, that where the rolling screen is used it would be well to place the magnets of the ordinary horse-shoe pattern in the tail spouts of this reel, or in case of the separators only being used, the magnets should be placed in the spout which leads from the separator. The machine which collects the metallic deposit automatically is more effective and convenient, though more expensive, than the horse-shoe magnet. However, the cost is not great. A miller can well afford to be quite lavish in the use of magnets. The writer remembers to have heard the president of the Millers' National Association, in one of its meetings at Chicago, say that he had used the magnet in connection with bran as well as in various other parts of the mill, and in every instance they made collections of foreign metallic substances. While this illustration was an extreme one, it merely shows the general effectiveness of the separation. The saving in bolting cloth by their use is very great.

After the wheat leaves the separators it should be run to the scouring

machine, if a cockle machine be not used. In a mill of this size it is hardly to be expected that more than one smutter or scouring machine will be used, though two would do the work better and more economically. But considering that we have the benefit of the scouring action of the rolling screen with the square wire, we will not include more than one other scouring device. in which event we would use one which will handle the wheat with the greatest severity, yet without the possibility of injuring the external bran coating.

After the wheat leaves the smutter it is elevated to the first reduction stock bin, or in case the larger size machines be used, as suggested. it would be of advantage to pass the wheat through the cleaning machinery a second time, if the means are at hand to do it, or if it can be conveniently arranged so to do. This would merely include the use of an extra bin. The greatest benefit which the wheat would derive from the repetition of this process would be that the wheat cleaning and scouring might be more gradual, and for that reason more economical and more efficient. Not only would it be more economical as to yield, but, as has been stated before, it would reduce the proportion of low grade, in that there would be less stock out of which to make low grade flour —less low grade stock in the mill. Much has been said before on this subject of wheat cleaning, but the writer is encouraged to keep on saying, for he believes that the next advance which is made in a general way by the millers throughout the country will be through the medium of wheat cleaning methods.

In a conversation with a miller, it was remarked that he cleaned his wheat very well, very thoroughly, and for that reason his screenings were rather rich. It has been practically demonstrated to the writer that the fact that the screenings were rich does not indicate that all of the screenings have been taken out of the wheat, or that the wheat has been well cleaned. It is entirely possible to have very rich screenings—screenings with quite a proportion of wheat in them, and at the same time to have wheat which is imperfectly cared for. The successful cleaning of wheat, successful as to the ultimate result and successful in that it is done economically, can be accomplished best by gradual methods. We discovered first that we could get the most middlings by gradually reducing the wheat. Afterward we discovered that middlings could be best purified by a gradual process. It remains to be developed in the minds of a majority of millers that the wheat can be best and

most economically cleaned in a gradual manner. There are those who acknowledge that the wheat can be best cleaned in this way, but who would not be so ready to acknowledge that it could be done the most economically in this way. As a matter of fact, of recent development, the yield of flour from the wheat can be appreciably lowered by the multiplication of the wheat cleanlng machinery. Not only will the quantity be greater, but the proportion or yield of high grades will be much larger than when less gradual methods are adopted.

The man who tried the experiment of adding to his wheat cleaning plant for the purpose of more perfectly cleaning the wheat, discovered the facts as here represented, that he took less stock out of the wheat, a smaller proportion per bushel with the grader, than he did with a lesser number of machines. The reason for this may be understood when we remember that in the ordinary effort at wheat cleaning, where we have to do the best that can be done at one or two operations by the separator, the suction has to be stronger for the purpose of making a separation, stronger than it might be if the feed were lighter and if other operations were to follow. It is clear that the gradual removal of impurities from the wheat is more efficient and more economical, and in every way more satisfactory, than when less gradual methods are in use.

If we stop to think of the methods of middlings purification as compared with the methods of wheat cleaning purification, we can notice the analogy—understand and appreciate the necessity for a similarity of means. We know that one or two operations will not do much good on a large volume of ungraded middlings, but we are not so well aware that operations founded on the same idea, which include two or three handlings of this grade of stock, are in very common use, and without apology or without acknowledgment that it is not right. A miller who purifies his middlings on such a plan would have it in mind to add to his facilities as soon as opportunity offered, as soon as he had money, or as soon as some other thing happened to enable him to make the change. Still he will go on in the same old way, year after year, in the cleaning of his wheat, without thinking that there is a better way. There are not many millers who would think to reduce their yield five or six or eight pounds per barrel and their low grade two or three or four barrels per hundred, by doubling the number of wheat cleaning machines in the mill. Yet this is just the thing that was done, and with the result here stated.

Within this last year or two we have all seen a number of horizontal scouring machines come into the market—machines with horizontal shaftings, or those which may be driven directly from a horizontal shaft. Such machines have met with great favor, other things being equal, with the millwrights, in that it does away with almost the only necessity for an upright shaft in a mill. During modern times such shafts have been decreasing in number until now we have mills which entirely dispense with their use—certainly a very agreeable condition of things. Scouring machines which have the vertical shaft, that is, the upright machines, have points in their favor, which statement might be made in regard to any machine; or it might be said, on the other hand, that the horizontal machine had points against it. It may be remembered, as a general statement, that every machine is a compromise. There is a compromise in the roller machine as compared with the millstones; there are points of excellence which distinguish each of these machines one from another. But to return to the horizontal cleaning machine: One thing which may be said in its favor is on account of the rolling action, the natural scouring action which it may be made to have in the treatment of the grain. There is the throwing of the grain against the side of the cylinder, its rolling down, and its throwing back again. In the upright machine the gravity action is not materially instrumental in scouring. It, as a general thing, merely has the effect of getting the wheat from the machines. The writer does not wish to express any particular preference for the horizontal machine, but merely mentions this point as one which occurs to him.

As mentioned once before, one great reason why the larger middlings (those which will pass through a 00 and 000 cloth) are not purified or aspirated, is that they do not show to the eye the beneficial effects of purification that the finer middlings do, though the result is very marked when we consider the amount of material which may be removed therefrom, and the yield of high grade flour which may be derived on account of their increased purity. For the same reason, it may be said that wheat cleaning methods are not followed up with the same vigor or the same interest. Wheat does not show as great a change in its appearance after it passes through the wheat cleaning machines as it does after it passes through other machines in the mill. That is, the changes to the eye are not so great, though there is no place in the mill wherein the general results can be affected more appreciably or more profitab

The writer thinks that he notices a difference in the wheat cleaning methods of the winter and spring wheat sections; notably, in the scouring of the wheat. There has been a greater tendency in the millers of the latter section to treat the grain more severely, to use machines which handle it more vigorously than do the millers of the winter wheat region. One reason for this, as understood, is that spring wheat needs more cleaning, or rather shows the effects of cleaning more plainly than does the winter wheat. There is more in the spring wheat to take out by the cleaning machinery, and for that reason it receives more attention. This leaves the miller to plan and to work and think more about what he is doing. Without increasing the number of operations in the wheat cleaning part of the mill, its severity has been increased in a large number. It would appear that the methods which accomplish the results with the least absolute fracture to the bran are the ones to receive the greatest attention, to be most economical and most certain to meet with permanent and lasting favor.

We hear very little about systems of wheat cleaning as compared with systems in other parts of the mill. In the future we will hear more about wheat cleaning systems. Combination machines will certainly do more good as devised for wheat cleaning than for most other operations of the mill. The combination idea for a wheat cleaning machine is entirely feasible. It consolidates the mill and is economical.

Having followed the wheat to the first reduction bin, we may go with it a little farther on its way to the reduction rolls. The next thing possible and advisable to do is to pass it through wheat heaters. They are another of the indirect purifying agents—indirect in that they do not make an absolute separation, yet they render a separation possible. They toughen the bran by drawing the moisture from the interior of the berry to the outside, thus making the interior dryer and more brittle, so that it yields a larger proportion of middlings. Wheat heaters are hard to take care of. They require a good deal of attention in order to keep the wheat uniformly heated. Drips from the various connections is one of the things which make wheat heaters obnoxious.

One of the great points of difference which will be noticed in the description of the 50-barrel mill will be the effort to produce a smaller grade of middlings by using somewhat finer corrugations for the first reduction, and finer wire for the scalpers. The elaborate preparations which are necessary to take care of very coarse middlings can not be

included in a plant of this size, and while it is not usual to make a distinction in the size of the middlings according to the size of the mill, it is better, for all reasons, including the quantity and quality of the flour, as well as the cost of the plant, that this be done.

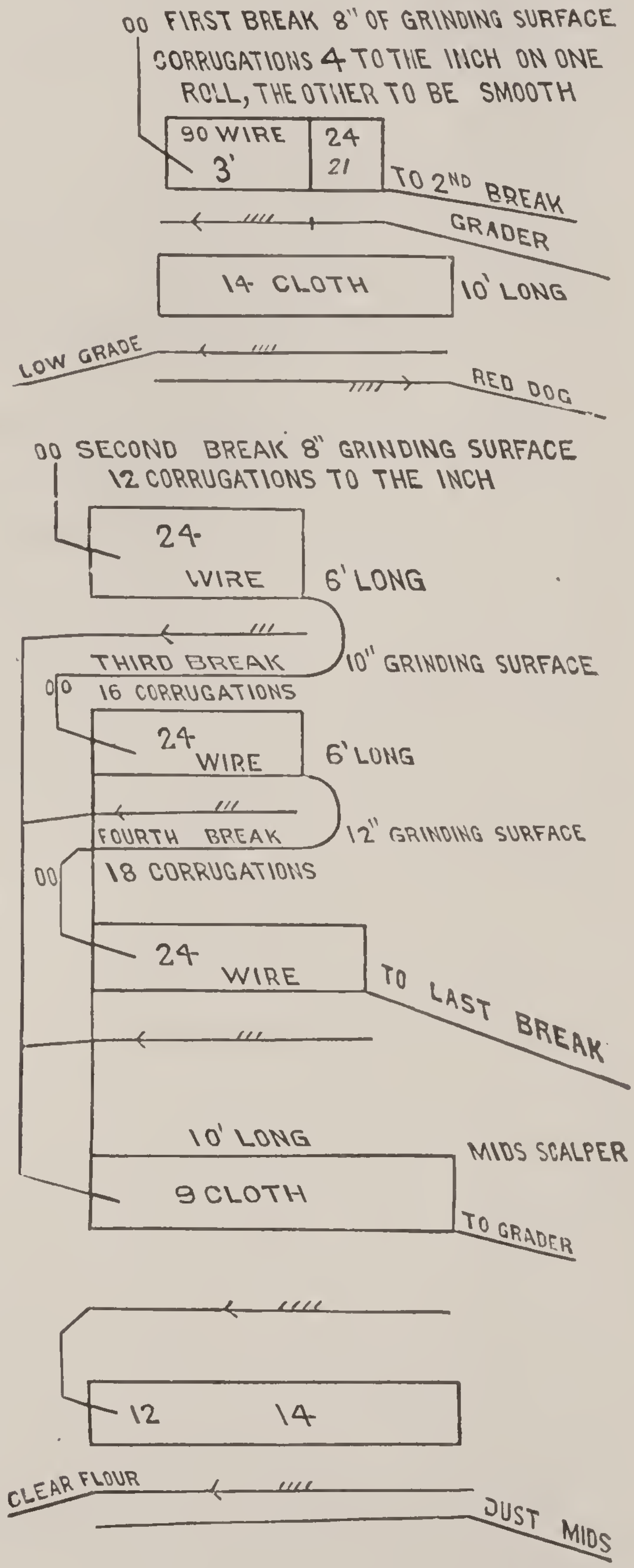
CHAPTER LXXI.

BREAKS FOR A 50-BARREL MILL—CLOTHING OF SCALPERS—FIRST BREAK.

As has been the practice, we give a fragmentary diagram which considers that part of the mill which is under immediate consideration. It would be entirely possible to give, in formulated shape, the length of the rolls, their number, the numbers of the reels and their kind, and a list of the other machinery, and then say that the mill was planned on the same general scheme as the others which have preceded it. There are reasons for not doing this. First, every one has not read and may not feel inclined to read all that has gone before. Then, again, there is always something to learn, by the writer, at least, by going through these diagrams and giving the reasons for the faith there is in them. The reasons for a fact or a conclusion are often more valuable than the fact or conclusion itself. The reasons which lead one to adopt one system rather than another for milling, lead one to consider more intelligently and more thoughtfully the practical handling of the methods which have been logically deduced.

In considering the run of the stock in the mill as it has been done in these chapters, there has been developed almost unconsciously a system which applies to all mills; that is, a milling system, and at the same time that it has been here developed and in this connection, it can not be claimed that it is an individual system, or one for which the writer is entitled to any credit. He has tried to connect and systematize the experience of others as well as his own, and has never hesitated to set aside individual ideas and individual preferences. As to the system: It may be said that it has been given in detail at other times, and perhaps with more detail, with finer classifications than are readily perceptible. Given in the rough, it would appear as follows: First break stock from the corrugated rolls, which is flour, middlings and dust middlings. As a tail from the last corrugated roll, there is the feed. From there is the purified stock from the tailings. From the reduced middlings there is the patent flour, dust middlings and tailings. From the reduced tailings there is clear flour, red-dog stock and a low grade of dust mid-

dlings. Then there are the dust middlings which, when reduced, make clean flour, and a cut-off which is the second dust middlings and that which goes to the red-dog. Then there is the reduction of the red-dog, which produces low grade flour and fine feed. This is all there is to any mill, and on this scheme a successful mill of 50 or 5,000 barrels a day may be constructed. The elaboration is a matter of detail, and does not affect the principle.



For the diagram: It will be noticed that the first break is clothed with a short piece of No. 90 wire. No. 90 wire is equal to No. 8 bolting cloth. The stock from this reel may be sent to a short reel clothed with No. 14 cloth, or it may be sent direct to the red dog stone. The reasons which would prompt the running of this stock direct to the buhr would be those which had the strictest regard for the cost of the plant, rather than reasons which had in mind the best results when viewed from a business standpoint. The tail of this first break scalper is clothed with No. 24 wire. It is well known that this is much finer cloth than is usually put on the scalping reel of this break. The reasons for this have been explained before, wherein it was stated that the middlings which ran through the 18 wire, which is the usual number, were coarser than could be economically handled in a mill of this size. An 18 wire equals a 0000 silk, and it is well known that the middlings which will pass through a 0000 cloth are nubs—ends

of wheat—middlings with adhering portions of bran. It is not possible to properly take care of this stock on a mill of this size. Thus the effort is made not to produce it. The No. 24 wire would allow a grade of middlings to pass through which is neither so fine as 00 nor so coarse as 000, and is a grade which may be readily handled on a mill with this capacity.

To go back a little, it may be noticed that the first break rolls have 8 inches of grinding surface, and that one roll has four corrugations to the inch and the other is smooth. This sort of a dress to the rolls, or rather this arrangement, appears to meet with more favor than any other at this time. A break made by such a combination appears to be some little better than by the other methods. On first thought it would appear that 2 feet for the tail cloth of the second break scalper was hardly enough, but when it is remembered that a scalper 6 feet long will separate the middlings on a 500-barrel mill, that is, those made on the first break of such a mill, it cannot be consistently maintained that this would appear to be too short for a 50-barrel mill.

The second break has twelve corrugations to the inch, and the same number of wire on the scalper as mentioned for the first. It is usual to progress in fineness of cloth from the first break. The reason of this is that it is usual to take out the coarsest middlings made at each reduction, and as the coarsest middlings are on the first reductions, the coarsest scalping cloth is there used; and as the middlings decrease in size, the grading cloth also decreases in fineness as it progresses toward the end. But, as said before, and as there explained, we do not take out the coarsest middlings made on any reduction until we get to the fourth. We merely take out the middlings that we want, and as the coarsest we care for are those which will pass through a No. 24 wire, we use nothing coarser than that number. As middlings are made on all the breaks to and including the fourth which are that large, we continue to use No. 24 wire throughout the course of that part of the mill. The fact that the middlings coarser than those which will pass through a No. 24 wire are run from one break to another—that is, from the first to the second, and the second to the third, and the third to the fourth, and so on, will give these breaks a little more to do than they would have under other circumstances. It is taking stock which has been once reduced, and reducing it a little finer. The corrugations of the first three breaks naturally make a grade of middlings which are larger than those which

will pass through the No. 24 wire, that is, none of the stock which should not properly go there will be seen passing over the tail of that reel to the fifth break.

It will be noticed that the grinding surfaces of the first two breaks are the same, and that we have 10 inches for the third and 12 inches for the fourth. This is a progression not common, it being usual to have the same number of inches for both the third and the fourth. Another thing, and that to which attention has been called many times before, is the increased length of scalpers, one to another. We have seen scalping chests made with five and six reels in them, depending on the number of breaks, all of which were of the same length. Now while it may be desirable to have the first break scalper a little longer than is necessary, for the benefit of the scouring and disintegrating action, it is not desirable to have the other break scalpers any longer than is actually necessary to take out the middlings, and it is apparent that any reel which would simply take out the stock for the second break would be too short for the fourth or the fifth, and that if it were long enough for these breaks, it would be so long that the second and third breaks would be submitted to a scouring and pulverizing action on the additional and unnecessary length of reel.

CHAPTER LXXII.

PURIFICATION OF MIDDLINGS IN 50-BARREL MILL—CLOTHING OF PURIFIERS—PRODUCT OF ASPIRATORS—FIRST MIDDLINGS—MACHINERY FOR 50-BARREL MILL—MILLSTONE REDUCTIONS IN 50-BARREL MILL.

It has always been the custom to take up the purification of the middlings after the consideration of the break stock, and in this instance, as in others, a sieve grader is used. The middlings are graded over Nos. 4, 2, 0 and 00 cloth, which makes five grades of middlings; that is, one grade for each number of cloth, and one grade which passes over the tail of the 00 cloth. Each grade of middlings passes through an aspirator on its way to the purifier proper, or to the sizings rolls. It will be noticed that the product of the No. 4 and No. 2 cloth, that is, the two finest grades of middlings, go to sieve purifiers. Because this mill is small, and because a plant of this size does not justify more elaborate arrangements, we would suggest that the purifiers which take this class of stock be double machines. By so doing there will be no particular sacrifice of principle. There is nothing wrong in using a double machine when the middlings which pass to both sides are of the same grade and same general quality.

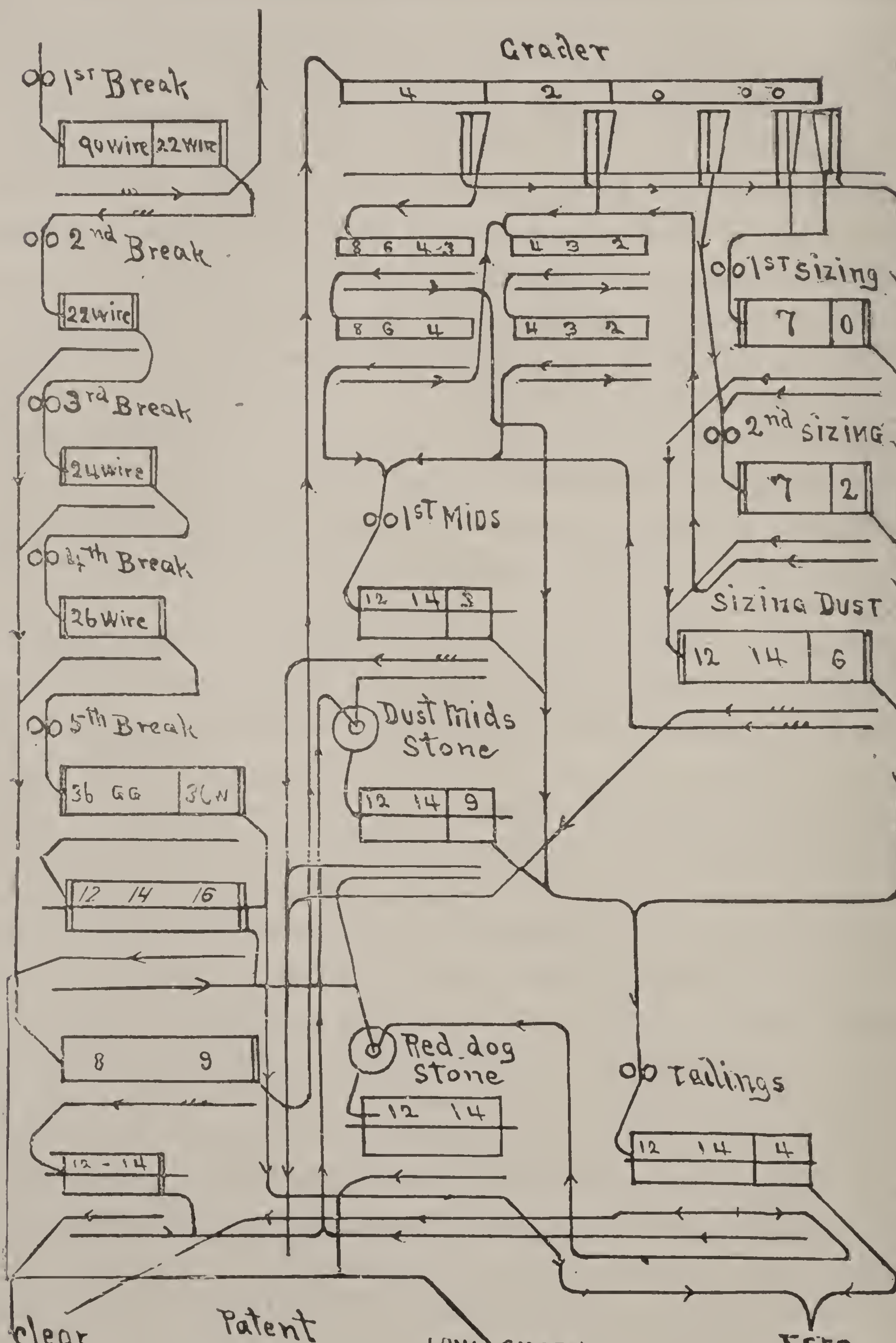
In the matter of the clothing of these first two purifiers, the writer refers to what has been said before in regard to their clothing. All remember when there was some mystery supposed to be connected with the clothing of purifiers and reels, but by this time most of us are satisfied with the fact that the clothing of machines and reels is a matter of almost common knowledge, founded on fixed principles. The clothing of a machine which is intended for bolting or purifying purposes is influenced entirely by the size of the stock to be handled. For instance, take this first purifier. The middlings which pass through the No. 4 cloth originally passed over a No. 8 or No. 9 cloth on a grader, therefore the middlings which pass through the No. 4 cloth on the grader will be of a size represented by the numbers from 8 to 4 inclusive; and for that reason the extreme numbers, head and tail, of the machines which handle that grade of middlings, will be represented by the extreme num-

bers mentioned. For instance, there will be No. 8 at the head, which is the finest, and No. 4 at the tail, which is the coarsest. It will be noticed that on the first machines which handle the middlings of this grade is sometimes put a number a little coarser than the grading number, which is done to cover contingencies of occasional overloading. However, we never use a number coarser than the grading number of the tail of the second machine. Any portion of the cut-off, if there be any, of the first machine, may be sent to the tailings. In this way the quality of the middlings going to the first machine may be exactly regulated so that the last cut-off from the bottom machine may be sent to the head of the machine which handles the last grade of middlings. The middlings which pass through the No. 0 and No. 00 and over the No. 00 are purified on aspirators, and, as has been said before, it can be well and economically done in that way. In fact, when these middlings are sized, as they always should be, there is nothing better to do with middlings of this grade. There is no machine which is better calculated to purify them and do it economically than these aspirators. It will be remembered that there is a very small amount of the middlings coarser than a 00 in this mill, this matter being regulated by the clothing of the break scalper.

The product of the aspirators which handle the two coarsest grades of middlings, that is, the stock which goes through and over the No. 00 cloth, is run together to the first sizing rolls, and is sized down from No. 00 to 0 middlings. This sized stock is dusted over a No. 7, and the product of the No. 7 is run into a reel which separates the flour from the fine middlings. The middlings which pass through the No. 0 cloth on the tail of this reel go to the next sizings rolls, and the tail of the No. 0 cloth goes to the tailings rolls. The product of the No. 0 cloth of the grader and the product of the No. 0 cloth of the first sizing reel go to the second sizings rolls, where the No. 0 middlings are reduced to the size of the next grade of middlings on the grader, that is, the No. 2 cloth. The same process of separation is repeated. The product of the No. 7 cloth of the scalper is sent to the dusting reel shown below on the diagram, while the coarse middlings, having all been reduced to No. 2 middlings, are sent to the sieve machines, which handle that grade of middlings. Thus we have our large middlings aspirated in the first place, then sized and scalped twice, and finally repurified before going to the first middlings rolls. The product of the No. 7 cloth of the two

scalpers, as said before, is sent to a reel which takes out the dust. This dust is patent flour, and the product of the No. 6 cloth on that reel is a most excellent quality of purified middlings, which are sent to the first middlings rolls.

The first middlings rolls take the product of the first two series of



machines, that is, the first four purifiers, and break the middlings again. It is more of a sizing operation than a positive reduction, and should be so regarded in the operation of the mill. For this reason a No. 3 cloth is put on the tail of the reel which handles the stock from these rolls. The product of the No. 3 cloth is sent to a millstone which reduces this stock to patent flour. The middlings here are called dust middlings. This may be hardly proper, though the dust middlings were run into this stock. This stock is reduced by the millstones, and the product is patent flour. The product of the No. 9 cloth goes to the red-dog. If it is desirable to make this mill a little more complete, which would be advisable, a better thing to do than is here shown would be to have an extra millstone for the purpose of reducing the middlings from the first middlings rolls, and another millstone for the purpose of reducing the dust middlings, and then the product of this reel might go to the millstone red-dog reduction.

The tailings from this mill run in a body to the tailings rolls. A good thing to do in a mill of this size would be to pass these tailings to an aspirator on their way to reduction. The stock which the aspirator would take would be the right kind of stock for feed. The flour from these tailings, which is bakers' flour, and the cut-off, or so much of it as is good enough, may be run to the dust middlings, while the tail may be run to the feed, probably through a bran duster.

In the drawing it is intended to show centrifugals where a horizontal line is drawn through the reels.

We can not use the same number of reductions or so elaborate a system of reductions and separations for a mill of this kind as for one of larger size. The use of millstones for the reduction of the middlings, and of centrifugal reels for the separation of all grades of stock from which flour is taken, helps to simplify and shorten the general process. For this reason such devices are largely used. The following is a list of machinery used in this mill:

Wheat Reductions—First break, 8-inch grinding surface; second break, 8-inch grinding surface; third break, 12-inch grinding surface; fourth break, 12-inch grinding surface; fifth break, 14-inch grinding surface.

Smooth Roll Reductions—Sizing for Nos. 00 and 000 middlings, 8-inch grinding surface; sizing for Nos. 2 and 0 middlings, 8-inch grinding surface; middlings reduction rolls, 14-inch grinding surface; tailings reduction rolls, 8-inch grinding surface.

Millstone Reductions—Second middlings, 1 pair; red dog, one pair.

Reels—Five break scalpers, 3 sizings scalpers and 1 middlings scalper.

Flour Reels—One break flour centrifugal, 1 tailings centrifugal, 1 first middlings centrifugal, 1 dust middlings centrifugal and one red-dog centrifugal.

Purifying Apparatus—One grader and 2 double sieve purifiers.

Summary—Five pairs of corrugated rolls; 4 pairs of smooth rolls; 2 pairs of millstones; 8 scalpers—short; 1 middlings scalper, 10 feet long; 6 centrifugals, 6 feet long. Purifiers: One grader and 2 double purifiers.

The above schedule includes as small an outfit of machinery as is possible in a mill of this size, and, in fact, this is as small as a mill can well be and yet carry out the principle of gradual reduction.

A mill of the kind here considered, and properly programmed with the machinery here set forth, can do good work, make good flour and clean feed—so much so as to be able to enter into the general markets for competition. One reason why this mill can do the work on the small amount of machinery here laid out is that in the programme it is arranged so that there is not a large proportion of large-size middlings to be taken care of, which will shorten, very materially, the work of the reduction machinery. The number of reductions for the purpose of getting this stock into flour is materially diminished thereby. It is coming to be known more and more that smooth rolls can only go about so far in the reduction of flour stock or in the reduction of middlings, from that of one size to a size smaller, and that any effort to hasten that operation defeats itself; that in so far as a reduction be attempted beyond the proper point, in that same proportion will the labor of finally reducing this stock to flour be increased. Thus if middlings be crushed down rapidly, as is the expression, they will be crushed, but not reduced to flour. They will be flattened, hardened, and the labor of getting that stock into flour will be largely increased by this effort at rapid reduction. Thus if the middlings are small, there is necessarily less work to do. As has been illustrated before, no matter how careful the miller may be in the reduction of stock by smooth rolls, there will come a time when it is next to impossible to go farther in the direction of making flour by the use of smooth rolls—a point where reduction by millstones appears to be a necessity. Say we take the reduc-

tion of middlings of a grade from Nos. 2 to 00. By the time that the roller machinery—that is, the smooth rolls—reduce this stock so that it will pass through a No. 6 cloth, or perhaps a No. 7, it is found that the middlings are as nearly purified as they ever will be, and, at the same time, that farther reductions by smooth rolls would merely harden the stock without making the desired amount of flour at a single reduction. The middlings being as pure as they well can be when of this grade and size, it is proper and economical that such middlings be reduced on mill-stones. Such a practice is sustained by the mistakes of roller reduction in this country, and by the general practice and recognized methods of the Hungarian mills. We have all talked all-roller mills to a greater or less extent ever since the introduction of gradual reduction methods. The idea is a very fascinating one: but all the time during the efforts which have been made to realize the proper results from such mills, the difficulties enumerated above—the difficulties in the complete reduction of the stock, have made themselves felt.

It is a common expression among many of the best millers of this country that the millstone still has a place in all first-class gradual reduction mills, and that gradual reduction does not, in theory or practice, forbid the use of the millstone. Gradual reduction has in mind the preparation of pure stock for final reduction. The middlings having been prepared and purified to the limit of possibilities, and having been reduced for that purpose, it is right and proper that the millstone be used to complete the reduction of this stock. Much of the stock which goes to the red-dog is in a condition to successfully resist the action of smooth rolls, hence the millstones are a necessity here. The writer thinks that he witnesses a general awakening on this point all over the country. Every miller whom he has seen and to whom he has talked, for some time, confirms this idea. Smooth rolls will go farther in the reduction of hard wheat stock without hardening or flattening it than they will on the soft stock. Hence, there is a greater necessity for mill-stone reductions on winter than on spring wheat. Nevertheless, spring wheat millers have been talking of this matter for some time.

A FIVE HUNDRED BARREL MILL.

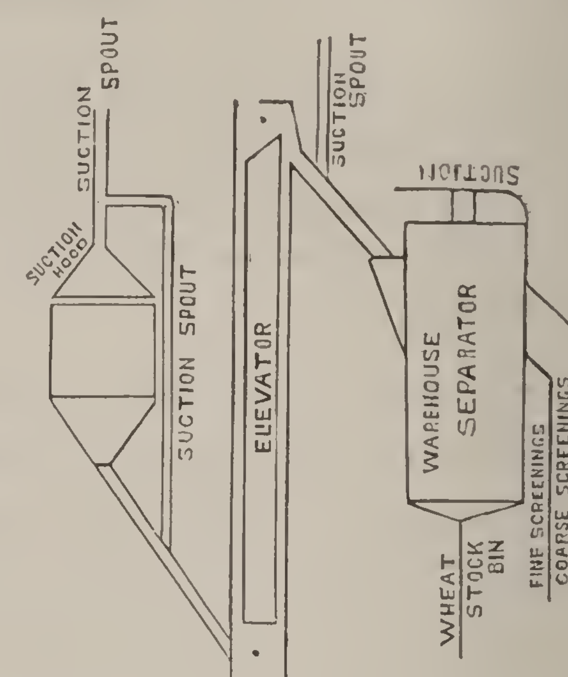
CHAPTER LXXIII.

WHEAT CLEANING OF 500-BARREL MILL—WEIGHING OF WHEAT—SUCTION OF DUST FROM WHEAT—WAREHOUSE SEPARATOR—WEIGHING OF WHEAT FROM SEPARATOR BINS—ROLLING SCREEN—MAGNET—WHEAT SEPARATORS—COCKLE MACHINE—SMUTTERS—WEIGHING OF WHEAT TO CLEAN WHEAT BINS.

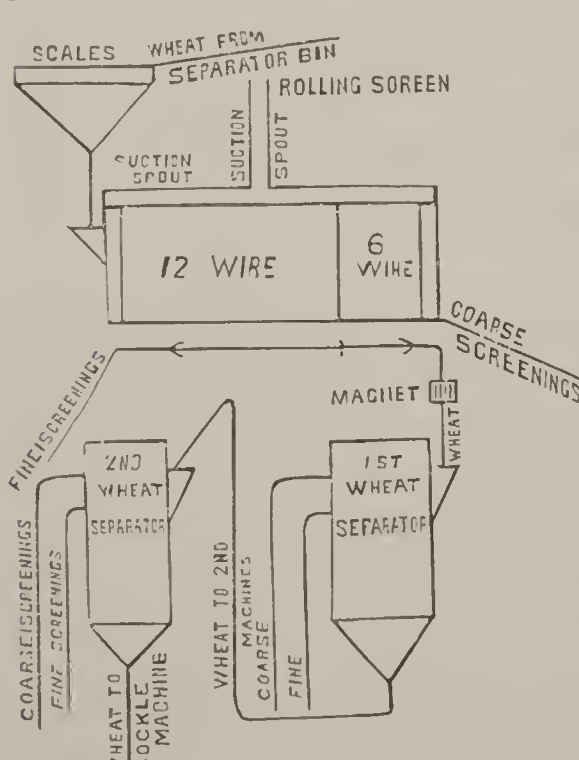
We will now take up the consideration of a mill of about five hundred barrels capacity, but, as said before, it is difficult to decide upon and arrange a system which is applicable, in the proportioning of the different parts, to all sections of the country and the various kinds of wheat. A mill which will make five hundred barrels of flour on one kind of wheat, may make more or less on other kinds. Furthermore, on one kind of wheat a larger amount of a particular kind of machinery may be necessary for its reduction and separation than on other kinds of wheat. For instance, a mill planned to work on a medium grade of winter wheat and do its work well at each particular stage of the process, might have more machinery than is necessary at one stage of the operation and less at others, when applied to the milling of California wheat of the harder varieties. Due allowance, therefore, has to be made in considering diagrams and formulas which are made from a particular standpoint.

We will begin a little earlier in the process of milling than has been common in the consideration of the other diagrams, and commence with the weighing of the wheat. In many mills the scales are placed at the bottom of the mill, though it is better that they should be at the top, and of a size to weigh in car-load lots. It is difficult to get scales of this size in the basement of a mill as ordinarily constructed, but without going into details in this matter, which is more one of mill engineering than milling proper, we will simply illustrate by placing the wheat scales at the bottom of the mill, and from thence will indicate in a conventional manner the cleaning and handling of the wheat. Over the scales there is marked a suction hood from which dust may be taken as the wheat enters the scales. This suction is also connected below the

scales. This arrangement is more particularly for the purpose of general cleanliness about the mill, than for the distinctive cleaning of the wheat, although it is an auxiliary process. The suction arrangement in and around the scales should present as little complication as possible, in order that it may not prejudice the sellers of wheat against the weighing apparatus. The hood should be arranged so that it may be raised or lowered. The suction under the scales would have the effect of keeping the working parts thereof clean, while the suction above makes it possible for the attendant to do his work without great discomfort, or the certainty of injury to his health. The same suction scheme is carried out at the head of the elevator for the same purpose, and according to the same general plan as indicated below. Suction spouts of the kind shown can be connected with any conveniently located fan; and it is well that the force of the suction should be quite strong, as it is hardly possible to create waste at this stage of the process by an ordinary draft.



The passage of the wheat from the elevator is shown on the diagram as being to the warehouse separator, the size of which would have to be determined by the size of the scales, or the capacity of the elevator. Before the wheat goes to the stock bins it should pass through a warehouse separator, in the manner here shown. As the wheat is wanted for use, it should be run into what is called a separator bin, immediately over or in immediate connection with the cleaning machinery. This bin should be hoppered so that it can be drawn out clear every day, or as desired. Before the wheat goes into it, it should be weighed, in order to facilitate the taking of the yield on each day's run.

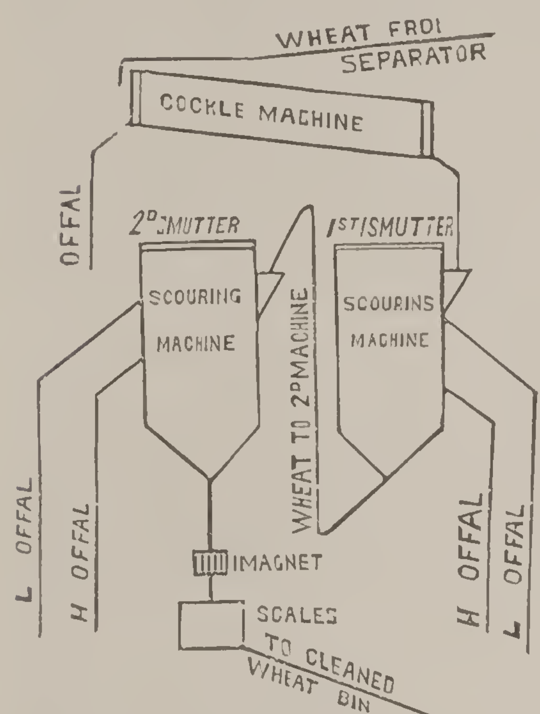


From the separator bin the wheat goes first to rolling screens; but before going into consideration of the details of this operation, we will consider how much wheat there is to clean. In the first place, say that we make 500 barrels of flour, and in order to be on the safe side with the cleaning machines in estimating how much they have to do, say that we take five bushels of wheat to make a barrel of flour. This, however, is too large a figure, but this calculation gives us a margin. Five hundred barrels of flour at five bushels per barrel makes 2,500 bushels of wheat to be cleaned in twenty-four hours. If the cleaning machinery be run to its minimum capacity, and during twenty-four hours in the day, we would need two rolling screens, 36 inches in diameter and 14 feet long; then there would be two of each of the other machines; that is, four separators, two cockle machines and four smutters of say sixty bushels capacity per hour each; or those of twice that capacity, which, however, would hardly do the work as well as the two.

This would involve a plant which is larger than is usual for a mill of this size, but in this instance the arrangement for wheat cleaning is on a basis somewhat different from what is usual in mills as ordinarily constructed. It is intended to carry out the idea of the gradual cleaning of the wheat as a part of the gradual reduction and gradual purification process, and as a part of that scheme, the limiting of the work to be done by each machine is considered necessary. If the wheat is cleaned gradually, a larger proportion of the objectionable material is removed from the stock, and at the same time a smaller proportion of the wheat itself will be taken out during the cleaning process, i. e., with the offal, the screenings, etc. It has been recently proved, as previously stated in this work, that the yield may be materially reduced by the gradual cleaning of the wheat. There will be less wheat going into the screenings, consequently more of it into the flour. The proportion of low grade is also reduced by the same means, in that the impurities are taken out of the wheat and do not have to be taken care of elsewhere in the mill. In this will be found a justification for the large plant of wheat cleaning machinery for a mill of this size.

As said before, there will be two rolling screens, which are to be 14 feet long and 36 inches in diameter. The head portion is clothed with wire to take out the screenings, and the tail portion with wire which will remove the coarse screenings by their passing over the tail, and allow the wheat to pass through the cloth itself. It is suggested that this cloth

be made of square wire instead of the round, in order that there be presented to the wheat the square scouring edges of the wire. By dividing this stream and sending it through the screen, it is sufficiently thin so that the wheat may be well scoured. The scouring will be better done than if the wheat all passed through one reel and then through another. The wheat which leaves the machine passes through a magnet to the first separators through which it passes, taking out the coarse and fine screenings and the dust stock, and thence through other machines of the same kind which do the same work. This multiplicity of operations on

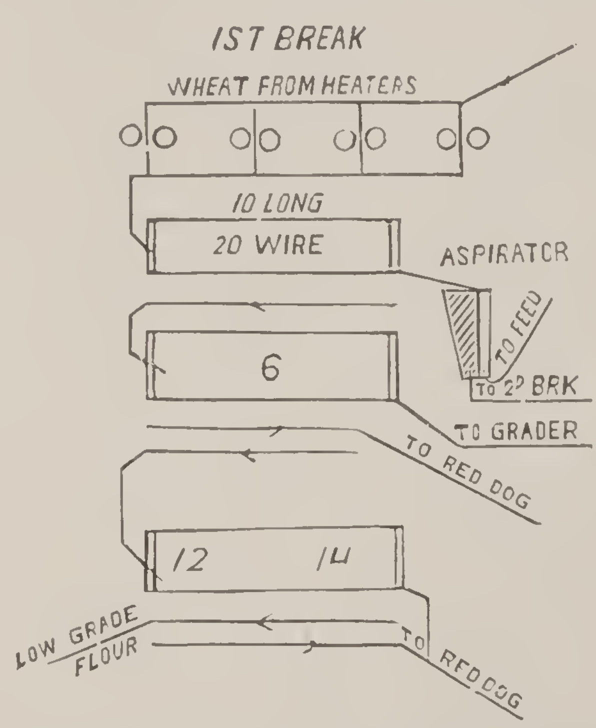


a light feed admits of the careful and economical work of which we spoke. At the same time that it is economical. it is thorough. After the wheat leaves the separators, and before it goes to the smutters, it goes through the cockle machines, at which point the round seed and other impurities of that form are taken out. From the cockle machines the wheat passes to the first smutters, or scouring machines, which remove the light and heavy offal at the same time that they scour the grain. It then passes through another smutter of the same kind, and thence through the magnets to the scales, whence it is weighed into the cleaned wheat stock bins. The weighing of the wheat in this way, before and after cleaning, indicates the proportion of loss by such a process, which is one step in the direction of giving a miller full knowledge of what he is doing, one day at a time. In this way there can never be anything wrong for a great length of time. By grinding out the bin every day and packing all of the flour from the packers at the same time, the proportion of flour of the various grades in connection with the amount of wheat used is ascertained after the manner described in a recent chapter.

CHAPTER LXXIV.

WHEAT HEATERS FOR 500-BARREL MILL—FIRST BREAK—REDUCTION AND SEPARATION OF FIRST BREAK—SECOND BREAK—THIRD BREAK—FOURTH BREAK—SEPARATION OF MATERIAL FROM THREE MIDDLE BREAKS—ASPIRATORS FOLLOWING THREE FIRST BREAKS—SEPARATION OF FLOUR STOCK FROM SECOND, THIRD AND FOURTH BREAKS.

On its way from the stock bins to the first break rolls it will be desirable to pass the wheat through wheat heaters as a means of toughening the bran and making hard and brittle the interior portions of the berry. This is done, as has been explained before, by drawing the moisture from the interior of the berry to the exterior. Thus we will have just what we want—a tough bran coating and a more brittle interior, which will increase the product of middlings. An ordinary copper heater, one of the usual size, as now made, will not heat in a uniform manner more than fourteen bushels of wheat an hour, and for this reason it will require quite a large number of heaters. One of the great troubles from wheat heaters is from leaky joints in the pipe which connects them. Considering the large number necessary, it is almost impossible to have them all tight at once. For that reason it is well to have the heaters placed a little to one side of the rolls, and adjacent to which there should be a platform readily accessible from a short stairway, which would facilitate the regulation of the steam supply and consequently aid in preserving a uniform temperature in the wheat. All that is necessary is that the water of condensation should immediately be carried from the heaters. It is not necessary to have a high pressure in order to get the greatest benefit from the steam. One pound of steam will do just as well as more. It is the latent heat which does

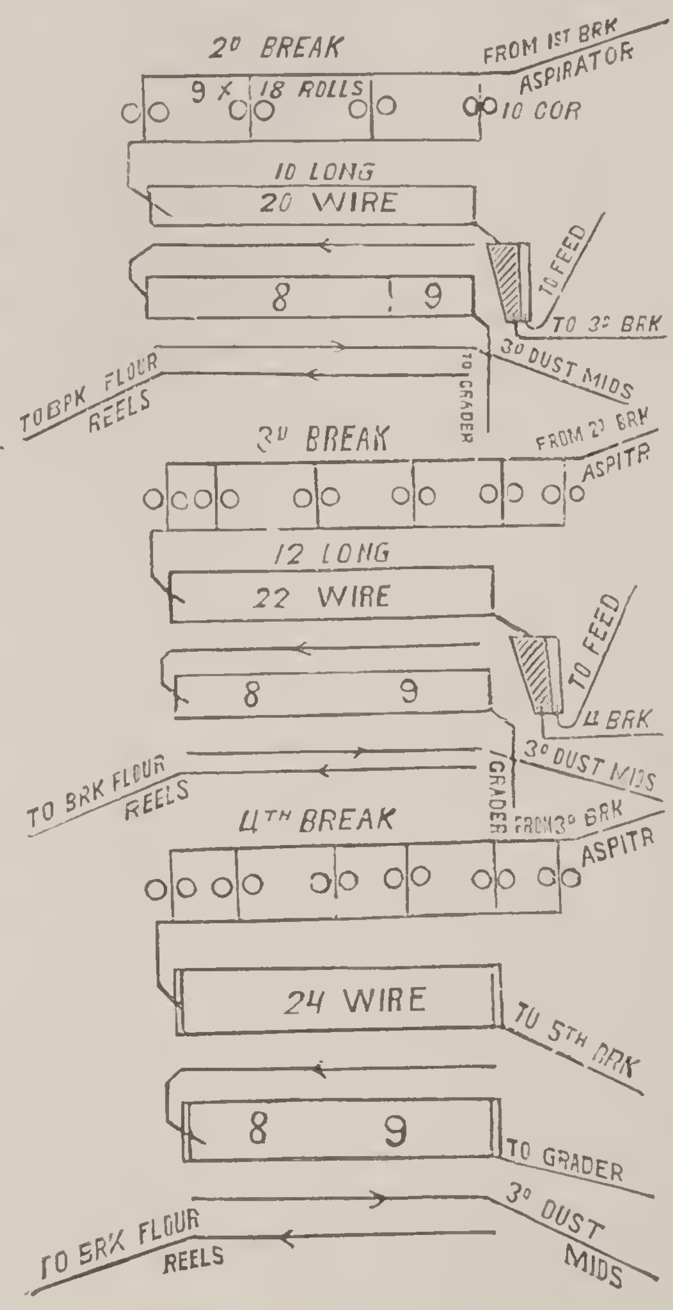


the work in this instance, and the amount of such heat is greater on a low temperature than on a high one. As to the desirability of heating wheat before grinding, there is no question in the writer's mind. It may be settled in the mind of every one who runs a mill, by carefully examining and testing the flour without the wheat heaters.

From these heaters we come to the first break. At the present writing, rolls, one of which is smooth and the other having four corrugations to the inch, are the most popular for the first break. However, it is only a little better than the ordinary first break by rolls. There is no particular difference between this and other first breaks which have been described, excepting possibly in the matter of separations, which are somewhat more complete. There are four pairs of 9x18 rolls. The wheat which passes from them goes into a scalper 10 feet long, clothed with No. 20 wire. This scalper is somewhat longer than is necessary in making a separation, but in it there is an agitating action which has the effect of dislodging whatever crease dirt may be in the grains which have not been entirely broken. The tail of this scalper on its way to the second break passes to an aspirator. The stock which is drawn out goes to the feed pile. There will not be much of it, and as a matter of fact there is less necessity for aspirating the first break than any other. Still it is possible to aspirate that break with less loss than any of the others, for the reason that it does take out a little stock, which accounts for the popular prejudice in favor of so doing at this stage of the process. There can not be much stock to take out from the first break by aspirating. In the nature of the reductions there is little, if any, of what is known as "fly-wing" bran, and other light stock of similar character.

The product of the No. 20 wire goes into another scalper clothed with No. 6 cloth. This is done to separate the middlings from the flour before bolting it. The middlings which pass over the tail of this scalper are sent to the grader. They are of good quality, large in size, somewhat irregular in form, however, and contain a large proportion of germ. It is shown that a certain proportion of the product of this No. 6 cloth may be sent directly to the red-dog. This is done in order that any of the red middlings stock which will pass through the tail of this reel need not be sent to the flour reel below. The product of the lower reel is, of course, low grade. The cut-off and tail from the reel go to he red-dog bin.

We next consider the second break. We have the same number of rolls and the same length of scalper we had on the first break. The corrugations of the rolls are ten to the inch. The clothing of the scalpers is No. 20 wire, the same number that we use on the first break, which number is a proper one to use in connection with the ten corrugations of the second break rolls. The tail of the second break scalper also passes to an aspirator on its way to the third break. In accordance with the general system in this mill, the middlings from each scalper are dusted or scalped by themselves, that is, the middlings from each break are scalped separately. In the present instance it is done on a reel placed immediately under the scalping reel of the second break. This admits of an examination of the middlings being made on each break, which affords the miller ready means of determining as to the quality of its grinding on each particular break. A great deal of bad work has been done by careless grinding and without knowing exactly where it was done. The arrangement of independent middlings scalpers for each break facilitates good grinding. Two conveyors are provided under this middlings scalper, so that any undesirable portion which passes near the tail of that reel may be sent to the third dust middlings. It is often the case that near the tail of a reel handling such stock as this, there may be found some very bad material, and this means of getting rid of it will certainly be very acceptable at such times. The general product of the reel, excepting what may be run off from the top conveyor, is sent to the break flour reel. Another advantage in this method is to be found in the fact that the flour stock may be seen and examined in detail, the product of each break by itself.

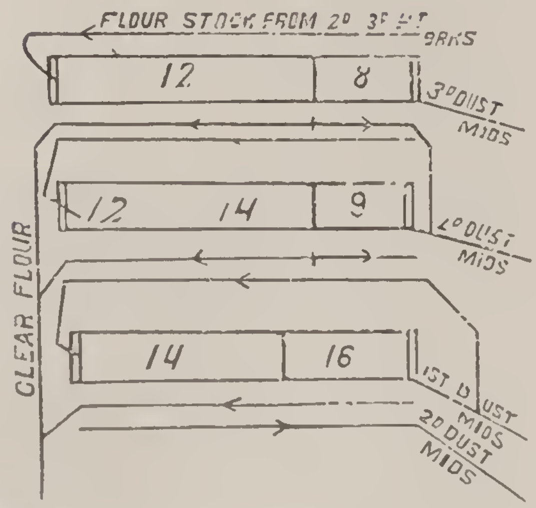


The third break stock is reduced on six pairs of 9x18 rolls, each of which has fourteen corrugations to the inch. The break scalper from this third break is 12 feet long and clothed with No. 22 wire. The tail of this reel also passes through the aspirator, and from it quite a proportion of stock is removed. Altogether a great deal more is taken from the aspirator than from the other two. This is the last break on which an aspirator may be used. Its use on the fourth or other breaks would be wasteful. The product of the No. 22 wire is scalped in the same manner as is described in the second break; that is, the middlings are sent to a grader, and any undesirable portion of the product of the scalping cloth is sent to the third dust middlings, while the general product of that cloth is sent to the flour reel. Another thing which is gained by running off this stock which falls through the tail of the middlings scalping reel, as is here shown, is in that it improves the quality of the dust middlings, which is very desirable indeed, as they are middlings which can not be purified in the regular way, because they are too small—too light. In this instance it may be said they are purified by discrimination; that is, certain stock which would contaminate this material is run in another direction, and removed from the dust middlings.

The fourth break has the same number of rolls as the third. The corrugations are sixteen to the inch. The scalping reel is 14 feet long, rather than 12, as was the case with the third break. This reel tails off to the fifth break, while its product goes into the scalping reel below, wherein the middlings are scalped and sent to the graders, and the flour product is sent to the flour reels.

Now we take the products of the second, third and fourth breaks and run them into the flour reels, separating the stock in the manner shown in the diagram. It will be remembered that most of this material has passed through a No. 8 and No. 9 cloth, though in reels which contained large middlings. Therefore there will be some tail over the No. 8 on the first flour reel, as shown. The No. 12 cloth on that first reel produces clear or bakers' flour, as does also the flour cloth on the reels below. The tail over the No. 9 cloth, and any sharp portion of the product on the No. 8 cloth on the reel above, may be sent to the second dust middlings by running out this stock from the tail of this upper reel. The stock which goes into the second reel may be kept soft enough to bolt well by this means. The product of any portion on the No. 9 cloth on the second reel may be sent to the dust middlings after having been

scalped on the reel above, and is sent to the reel below the first dust middlings. The third reel, having had a portion of sharp material reduced by running out a large proportion of dust middlings on the second reel, is in a good condition to produce a bright, clean flour. The tail of this reel goes to the first dust middlings, and the cut-off which is the product of the No. 14 or 15 cloth, is sent to the second dust middlings flour reel, which is better than sending it on to the rolls, as it would there prevent the sharper stock from feeding properly. In any event, stock which is so fine can be readily reduced at a single reduction. Therefore, any portion of it which does not pass through the third dust middlings flour reel will tail over and be reduced on the third dust middlings rolls.



CHAPTER LXXV.

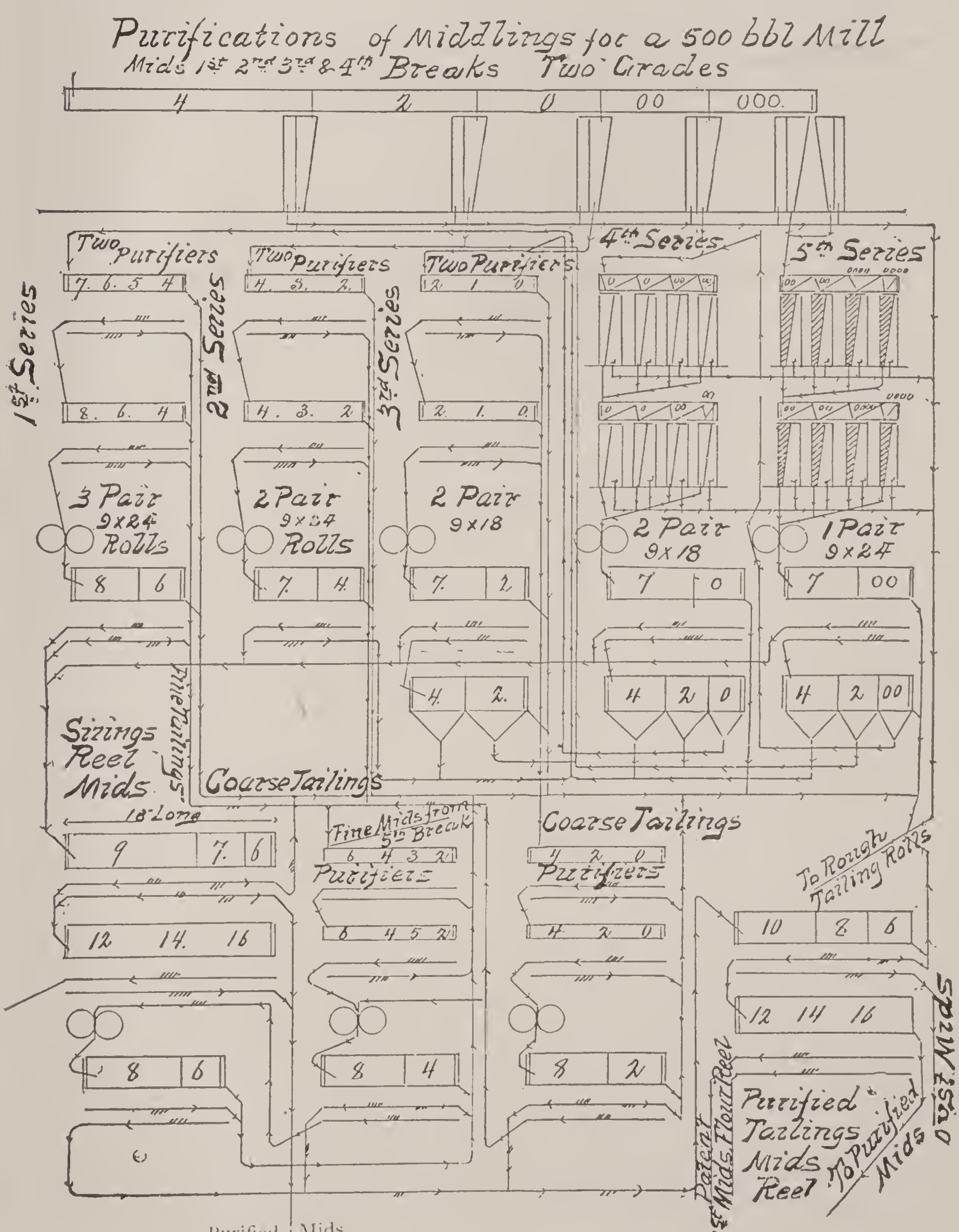
GRADERS FOR 500-BARREL MILL—METHODS OF REGULATING THE CAPACITY OF GRADERS—PRODUCT OF ASPIRATORS UNDER GRADERS—AN OUTLINE OF THE PURIFICATION SYSTEM OF 500-BARREL MILL.

The diagram which is here given shows the means for the purification of the middlings from a 500-barrel mill. As has been indicated many times before, the middlings pass to a grader, or, as in this instance, to two graders. They are of the ordinary sieve type, such as has been described in previous chapters, and would here be 40 inches wide and 20 feet long, which would give abundant capacity for the middlings from a mill of this size. The ordinary speed for such shakers is 275 revolutions per minute.

It may be known that in some mills operating on hard wheat, about 60 per cent of patent flour would be made, and in others operating on very soft wheat, 30 per cent, in which cases there would be a corresponding difference in the volume of middlings to be purified. The difference in the capacity of the shakers would be regulated by the speed. In the event of their having too much to do, the speed could be increased above the speed indicated. The travel of the middlings is regulated by the throw of the shaker and the number of vibrations per minute. That is, the middlings will travel just so far for a certain vibration. And if there be a greater number of vibrations, there will be a corresponding increase in the amount of stock which will pass over the shaker. Therefore, if the speed of the shaker should be increased to 300 revolutions per minute, proportionately more stock could be handled on that shaker. As may be seen on the diagram, the middlings are graded into six grades. It will be remembered further that in the diagram of the break separations, the middlings were dusted over a No. 8 cloth. Furthermore, that the coarsest break scalper was equivalent to No. 0000. Therefore we will have middlings coming on to this shaker which are as fine as the No. 8 cloth and as coarse as the No. 0000. Therefore there will be middlings passing through the No. 4 cloth at the head of the shaker which are as fine as No. 8 and as coarse as the grad-

ing number, that is, 4. Next we will have those which pass through the No. 2 cloth, which are as fine as will tail over the No. 4 and pass through the No. 2, and so on.

The sixth grade is made up of stock which will pass over the No. 000. Now for each grade there is shown an aspirator which is common



to all of these graders. The stock which passes over the slats is the middlings, and that which is drawn through is the tailings, which is indicated as passing to the rough tailings. This stock will be very poor indeed. Very little material can be taken out through the first aspirator, or that which takes the middlings which pass through the No. 4 cloth. Such stock will be light, fuzzy material, not large in volume nor very bad as to its general character. That which passes through the No. 2 and the aspirator in connection therewith will yield tailings of a quality somewhat lower than that of No. 4. It will be red and contain very little material which can be reduced to flour on the rough tailings rolls. When it comes to the stock which passes through the No. 0 and the aspirator in connection with it, the tailings which are drawn out will be almost poor enough for feed. It will be very red indeed, and very light. The middlings which pass to the other purifiers will show very white, and will be quite free from the poorer class of impurities. The No. 00 middlings will not show so white as the others, in that there will be middlings therein which contain adhering portions of bran, and the tailings will be very poor, very red and very light. The same may be said of the No. 000 middlings. They will be correspondingly darker, and the tailings correspondingly poorer. The stock which passes over the No. 000 and forms the sixth grade of middlings will contain a considerable portion of the red, foxy material which is passed along on top of the sieve. If there were other better means of separating this material from the stock, it would be adopted, for the reason that it is hardly proper to run this stock which tails over the sieve and the large middlings which go therewith, together. But as the middlings are very heavy, No. 0000 in size, and as the stock is very light, very little harm can be done by such a proceeding. The suction on the No. 0000 middlings may be quite heavy, and for that reason the impurities may be almost entirely removed.

As said before, there are two of these shakers, with the corresponding aspirators. The stream is divided so that there are four machines for each grade, or two for each one shown on the diagram, the middlings from each grader going to separate purifiers below. There is one set of machines for each grade excepting the last two, which run together and pass under the same machines. The arrangement of tails and cut-offs from these purifiers is somewhat different from that shown in the other diagrams. For instance, it has been common to run the cut off from

the first machine of each series with the tail of that machine. Again, it has been usual to run the cut-off from the second machine of each series to the first machine of the next series. By reference to the diagram it will be seen that a different course has been pursued in this instance. The tail of the first machine goes to the rough tailings, and the cut-off from the first and the tail and cut-off from the second machine of each series go to fine tailings. This arrangement is common to all of the purifiers. As to the aspirating purifiers, of which there are eight, the tail in each instance goes to the rough tailings, as does also the portion which is drawn through the slats.

Before considering this diagram in detail, it may be well to consider its general purposes and the general arrangement with that object in view. In that way it will be more easy to understand what is intended. In the first place, it is intended to pass the middlings of the various grades as they go through the graders, through the purifiers. Then it is intended to commence with the coarsest grade of middlings, and by gradual sizing to reduce all so that they will pass through a No. 7 cloth. This necessarily has to be done in a gradual manner, as it will be impossible to reduce coarse or other middlings more than one or two numbers at a sizing, unless it be the finer grades, which may be reduced three, or in some instances four numbers. But with the coarser grades this thing is impossible. There is an intermediate purification between each sizing; that is, the middlings of the coarsest grade, after having been sized or reduced, are purified on the machines of the next finer grade. All of this will be made clear in the detailed description.

CHAPTER LXXVI.

PURIFICATION SYSTEM OF 500-BARREL MILL—GRADING, SIZING AND RE-PURIFICATION OF STOCK—DUSTING OF SIZED MIDDLINGS.

We take the middlings which pass over the No. 4 cloth on the grader, and which pass to the first machine of the first series. This machine is clothed with Nos. 7, 6, 5 and 4. No. 7 is the number suggested by the cloth over which the middlings were originally dusted, that is, Nos. 8 and 9. No. 7 will let through quite a proportion of the finer middlings. No. 4, which is the tail number of this machine, is given from the grading number on the sieve grader above. The stock which passes over this tail number will necessarily be poor, as the sieve on the purifier will have more capacity than the corresponding sieve of the grader, in that the bulk of middlings will not be so heavy on the cloth, and again, the cloth will be kept cleaner. The better portion of stock which passes through the sieve is indicated as going to the second machine of the same series; that is, the first, and the portion which it is desired to cut off, is run to the fine tailings, then, again, the product of the next machine (that is, the one under the first, which is clothed with Nos. 8, 6 and 4—the finer number being suggested from the fact that we wish to carry the clean middlings a little further down on the sieve in the case of this second machine than we do on the first.) We may regulate the quality of the middlings taken from this second machine by the amount of cut-off which we take on the bottom conveyor. The product of this bottom conveyor, together with the tail of this machine, is sent to the fine tailings. The product of the upper conveyor is purified middlings, and is sent to the first sizing rolls. The handling of the stock on the next machines is exactly the same as on the first, and the same principle is observed in the clothing of the machines as has been mentioned so many times before; that is, the finer number is made by the number over which the middlings pass, and the tail number by the number through which they pass. There is no guess-work in clothing a purifier, and should be none in clothing a reel. It may be determined by something which comes before or something which goes after. The No. 0 mid-

dlings are purified in exactly the same manner as was shown in the other part of the diagram—that is, the first two series of machines. The middlings which tail over the No. 0 cloth, and those which pass through the Nos. 00 and 000 and which tail over the No. 000, pass on to the aspirating purifiers, a distinct type of machines, and which we understand from what we have read of them before. In each instance it will be noticed that these machines stand alone. There is no connection from the machines which handle one grade of middlings to that which handles another. None of the stock which passes from one machine passes forward to another. After the middlings have passed from the purifiers, and have, as is usually understood, been purified—that is, after all has been done on them that can be done with the purifiers without sizing—the sizing operation commences. We first will take the middlings which pass through the No. 000, and those which pass over the No. 000, that is, the coarsest grade. After they have passed through the two aspirators, and as we know, they will take out all that may be removed by a purifier, they pass on to the smooth rolls, the stock from which passes to a scalping reel clothed at the head with No. 7 and at the tail with No. 00. This No. 00 cloth fixes the setting of the rolls which size the middlings which go into this reel. There can be no change from this. If the rolls be set too close, the tail of the No. 00 cloth will be rich, or if they be left open, it will be too rich. They must be set so that the stock which passes over the tail of this reel will be poor and can be run to the rough tailings, as is indicated, without waste. The product of the No. 7 cloth is sent to the flour reels which separate the fine middlings from the flour. The product of the No. 00 cloth goes to a grading reel below, clothed with Nos. 4, 2 and 00. It may be well to say here that these scalping reels and the grading reels which come under them should be set over the purifiers, so that the stock which passes through them may be run to the purifiers, saving the trouble and expense of elevating the stock. It must be understood that the machinery in a mill cannot bear the same relation, one part to another, as is indicated in the diagram; for instance, where rolls are shown as coming above scalping reels, they more often come on the grinding floor below—say some three or four stories below. We said that the middlings which pass through the No. 00 cloth on the first reel went into a grading reel immediately below it, and that this grading reel was clothed with Nos. 4, 2 and 0. Then we take the middlings of each particular grade

as made by this grading reel, and send them to the purifiers which have been described above as handling middlings of the sizes here named; for instance, the coarsest of these middlings, or that which goes through the No. 00, goes to the No. 00 machine, and the next grade, which is the No. 2 middlings, goes to the machines which handle the No. 2 middlings, and that which passes through the No. 4 cloth goes to the No. 4, or finest grade of middlings. In each case there is a repurification of the middlings of the size indicated. The middlings are broken down, made finer, and then repurified. The middlings which pass through the No. 00 cloth go to the No. 00 purifiers, pass through those machines, come down on to another set of sizing rolls, and are then broken so that the coarsest will pass through the No. 0 cloth, or a number corresponding to the next finer grade of middlings, and the tail of the No. 0 cloth must, as said before, be stock which properly belongs to the rough tailings. The product of the No. 7 cloth goes to the reels before mentioned, which separate the fine middlings from the flour. Then, again, these middlings are graded, that is, the middlings which pass through the No. 0 cloth, and according to their grades are sent to the purifiers. This process is continued throughout. The middlings of the No. 0 grade have only to be graded into two sizes, that is, the No. 4 and the No. 2, there being only two grades of middlings finer than the one here mentioned. The middlings from the No. 2 grade require, after sizing, only one reel, as the tail number on that reel is the grading number on the next finer grade of middlings. The product of the No. 4 cloth passes to the machines which handle middlings of that grade. It will be seen that we have commenced with No. 000 middlings and gradually sized them, and at each sizing have graded them, and after each grading we have repurified them until we have all of a common size; that is, so that all will pass through a No. 7 cloth. Having scalped them after each operation, they cannot but be a very high grade of middlings. It will be noticed in the practical operation of such a mill that the middlings which pass from the sizing rolls to the purifiers are of a better grade than the middlings which pass directly from the sieve grader to the purifiers. There is every reason why this should be so. In the first place, they have been purified after leaving the several graders, by the sieve machines, then they have been sized and scalped, each of which operations is calculated to, and does, remove impurities.

CHAPTER LXXVII.

TAILINGS FOR 500-BARREL MILL—FINE TAILINGS—COARSE TAILINGS—ROUGH TAILINGS—PURIFICATION OF FINE AND COARSE TAILINGS—SIZING OF TAILINGS—GRADING OF REDUCED TAILINGS STOCK—COMPOSITION OF ROUGH TAILINGS.

We have spoken of coarse and fine tailings. The fine tailings are made up from the tail of the second machine and the cut-offs from each of the sieve machines of each series finer than the No. 0 grade, while the coarse tailings are made up from the No. 0 grade. Into the fine tailings we run the middlings from the fifth break. These fine tailings represent a quality of stock which in the smaller mills we have never been able to consider. There is a grade of stock in every mill, noticed by every one, which is neither middlings nor tailings. It is too good for tailings and not good enough for the middlings, and in ordinary operations on a small mill, each miller has to draw the line as pleases him best. He runs stock into the tailings which should not go there, and he runs stock into the middlings which he would run some place else if he could, but does not feel like running it in with the tailings. In a 500-barrel mill there is an opportunity for distinct treatment, and if treated in the proper way, this stock may be purified and reduced so as to yield quite a proportion of good flour. Under other circumstances it would be clear and low grade. The method of purification is somewhat the same as with the general middlings above mentioned, excepting that all stock which is rejected either as a tail or as a cut-off is sent to the rough tailings, for there is nothing else to do with it. The fine tailings is next in grade to the middlings, the middlings being of a better quality and next to the rough tailings as well, such tailings being next purer in quality. The method of sizing is also the same as that of the middlings, excepting that it is the object to reduce these middlings so that they will all pass through a No. 8 cloth, rather than a No. 7, as before. The first sizing operation is such as will reduce the coarser purified coarse tailings so that they will pass through a No. 2 cloth, which may be readily done. That portion which is not desirable to send in with the fine tailings

is sent off with the rough tailings. The product of the No. 8 cloth is sent to a reel which will separate the middlings from the flour. The stock which passes through the No. 2 cloth on the sizing of the coarse tailings, or the desirable portion of it, goes to the fine tailings for repurification, and the fine tailings as they are purified go to their own sizing rolls, and are reduced so that the tail number may be 4, or the finest grade of fine tailings; and then the product of the No. 4 is sent to another set of rolls, which reduce it again so that the tail number of the reel under those rolls may be No. 6. Thus we have the middlings from the tailings of the better grade reduced so that all will pass through a No. 8 cloth. We take the product of the No. 8 cloth of each reel and run it to the reel which is designed to separate the flour from the middlings, which is shown in the diagram, which is clothed with a No. 10, 8 and 6. The stock which passes through a No. 10 cloth goes into the flour reel below, or even a portion which passes through the No. 8 may be sent in the same direction. The undesirable portion of the stock which passes through the No. 6 cloth may be sent to the rough tailings, if there be such portion, or all or any part of the No. 6 cloth product may be sent to dust middlings. The product of the flour from these reduced tailings middlings will be largely patent. A portion of it may be clear. The tail from the second reel is purified middlings, which goes to the purified middlings bin. The quality of these middlings will be regulated by the quality of the stock which has been tailed off or cut off on the tailings purifiers, and the quality of the stock which has been cut off to the dust middlings on the upper reel here shown. But the middlings can hardly be so bad but that the stock which was sent to the purified middlings from the tail of this reel will be a most excellent quality, as will be the stock which is taken from the upper conveyor of this reel. Altogether it is an arrangement for the purification of this intermediate grade of stock which will save it from a lower grade of material, a grade which would otherwise bring considerable less money.

At the head of each of the scalpers for the sizing rolls there is a No. 7 cloth, the product of which is shown as going to a set of reels which are intended to remove the middlings from the flour. These reels are 18 feet long, and, as shown, the first one is clothed with Nos. 9, 7 and 6 cloth. The product of the No. 9 cloth is sent to the reel below, and the product of the Nos. 7 and 6 may be sent to purified middlings, or a

portion of the No. 6 cloth, if the quality of the stock warrants it, may be sent to the rough tailings. It is hardly probable that this will happen, however. The second reel is clothed with Nos. 12, 14 and 16, which produces patent flour. The cut-off and tail from this reel go with the desirable product of the Nos. 7 and 6 on the reel above, and represent purified middlings of the best grade in the mill, and from which the best flour will be produced. Anything else which may be desirable to be understood from this diagram, is clearly shown in the diagram itself.

CHAPTER LXXVIII.

COARSE AND FINE TAILINGS—THEIR DEVELOPMENT INTO PURIFIED MIDDLINGS, FLOUR AND ROUGH TAILINGS—MEANS FOR REDUCTION OF MIDDLINGS IN 500-BARREL MILL—CHARACTERISTICS OF STOCK TO BE REDUCED—QUALITIES OF MILLSTONE REDUCTIONS ON MIDDLINGS—JUDICIOUS USE OF MILLSTONES—OLIVER EVANS' IDEA OF MILLSTONE REDUCTION.

In the completion of the chapter on the purification of middlings for this 500-barrel mill, we neglected to say that all the stock which went to the graders was finally worked into that condition wherein it was either purified middlings or rough tailings. The middlings were purified and the offal was run into tailings of the various grades, that is, either the fine, or the coarse, or the rough tailings; and that portion of the better grade of tailings, that is, the fine and the coarse, were purified and reduced, and repurified and scalped, until that portion of this stock which could be run off as purified middlings, or as dust middlings or other middlings, was so done, in a manner to leave only rough tailings as a residuum or an unfinished product. Thus we do not have to create or arrange for additional reductions for tailings, as is frequently the case in mills of this size, where the tailings are so graded. This thing is accomplished by the purification of this higher grade of tailings, and by the separation of the reduced material as is dictated by its quality. It may be, as said before, either purified middlings, dust middlings, or other stock of lower character.

Having finished what we have to say in regard to the purification of the middlings, it is in order that we consider their final reduction into flour. Now, it should be known, these middlings were originally produced by the corrugated rolls, and they were purified by the agency of the ordinary purifiers and the smooth rolls and scalpers which followed. A large portion of these middlings were reduced a number of times by the smooth rolls during the process of their purification and repurification, and for that reason they may be considered as smooth roll middlings; that is, middlings which have been largely produced by smooth

rolls—broken down from the larger stock. Having been submitted to this operation a number of times, it would hardly be possible to further reduce it with any degree of completeness by the use of additional smooth rolls. There is a tendency, as we know, in all stock, after having been touched a number of times by these smooth surfaces, to become a little flat and somewhat feathery in character, so much so that it is hardly possible after such a number of operations to continue such reduction successfully; therefore we have decided in this instance to reduce the middlings for the first time after they have become what we will call purified middlings, by millstones, after which operation we may again resume their reduction by the smooth rolls. The millstones have a tendency not only to reduce, but to liven the stock again, make it round and sharp, and to bring it into the condition which will admit of its further reduction by the smooth rolls. It is well that this millstone reduction should come at such a time in the stock when the proportion of impurities is the least, as it will be when leaving the sizing rolls and the purifiers which we have mentioned. After another reduction there would be a smaller proportion of real middlings, for the reason that considerable flour would be taken out, and the general bulk of material thereby reduced.

Soon after the general introduction of corrugated and smooth rolls for the purpose of milling wheat, it became a generally accepted idea among many millers that a millstone had no place in a gradual reduction mill —that nothing but corrugated and smooth rolls, or scratch rolls, could be used, and the millstone by many was regarded as a relic of a barbarous method of reducing wheat which was past. We have heard a great deal said about it by the roller mill people and others—that "There is a mill without a millstone in it," and all that. This is an idea which had a good deal of fancy and a good deal of pride to back it, and it was an idea which cost a good many people considerable sums of money. Now, it may be possible to do without millstones in an ordinary gradual reduction mill, and a great many have abandoned their use entirely, but there is a feeling, which we recognize, and have spoken of before, that there is something wrong in this—that there is a place for the judicious use of millstones in any mill of this kind. In those as ordinarily constructed, it is at the tail end of the mill, perhaps, but in a mill arranged as is this one, where the middlings are sized so many times in the course of their purification, a millstone reduction is entirely proper

and right. Again, if middlings are properly treated on buhrs, their reduction thereby is not so barbarous a process, after all. We would suggest something of this kind: First, that the buhrs be balanced and dressed very carefully, that the surfaces be smooth, the furrows large in number, and that the speed of the buhrs be not more than 130 revolutions per minute, say, for a 48-inch stone; and in the grinding by these buhrs, we would say that they should not be set close. It is not necessary that middlings which have been purified as have those which we have been considering, be mashed down by being ground very closely. It is antagonistic to the ideas of good milling that such a thing should be done. They should be ground as high as possible, in order to produce a clean flour through a No. 12 cloth on the first reel. Now, as all of this stock has passed through a No. 7 or 8 cloth, most of it through a No. 7, it is easy to see that a vigorous reduction is not necessary in order to bring it down to the flour numbers. Not only is it not necessary as a matter of reduction, but it is entirely wrong as influencing the character of that reduction. If we grind close, as close as we well can, or anywhere near that point on the middlings, we are doing what most people claim that the buhrs will do, that is, pulverizing impurities in all grades of stock alike. But we may grind so that only that part of the material which is susceptible to the action of the millstones will be reduced, and that the impure material, which is somewhat tougher in character, will hardly be changed as to its size, and for that reason will pass over the tail of the scalping reel of the middlings reel. High grinding on middlings represents one character of work, and low grinding an exactly opposite character. High grinding fulfills an idea of gradual reduction, in that it is gradual and does not reduce the impure stock, and for that reason has its place in any gradual reduction mill.

It has been expected that something would be said in the course of this work about millstones, and the writer has looked around a good deal and has thought considerable as to what would be said, and as to what would be new and fresh on the subject, as well as what it would be proper to say. It is proper to say here that the experience of the author has not been entirely with gradual reduction machinery, that is, the roller machinery, but that his first training and first work was with the millstones, with which he had considerable experience. He has arrived at this opinion: That nothing better ever was said about millstones or

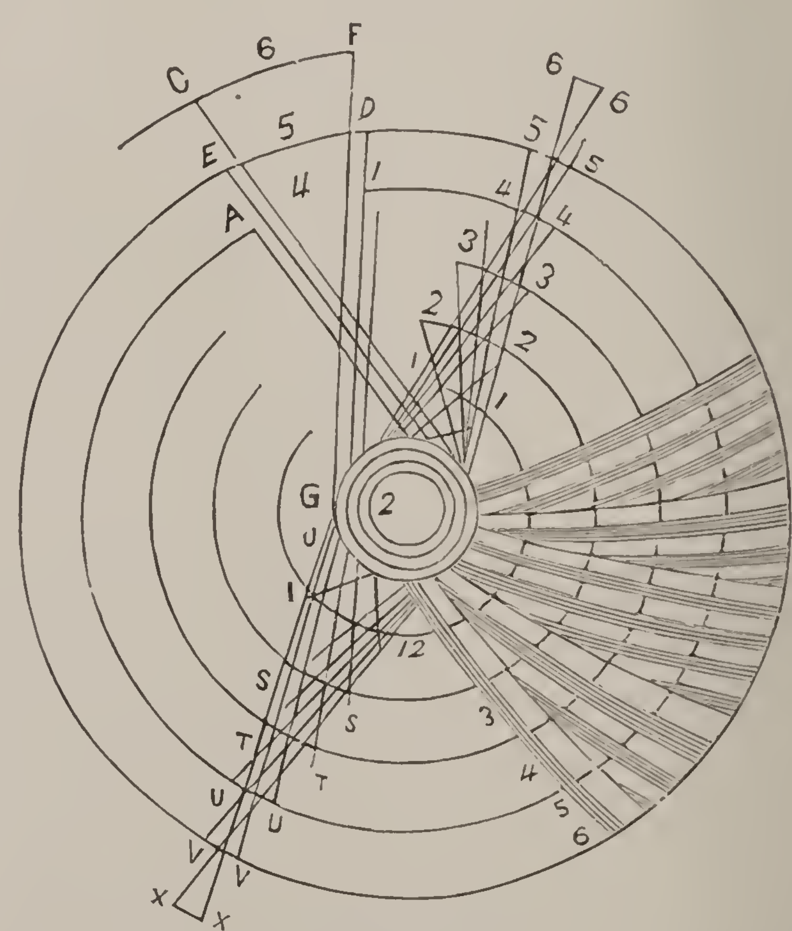
about a millstone reduction than was said by Oliver Evans, who died in the year 1819. His expressions in regard to the principle of buhr grinding are abreast of the times. Nothing better has been given to us, and those who are using buhrs for reducing middlings and other stock in the gradual reduction roller mills, cannot do any better than read what has been said by Evans, and it is here presented. While it has been the intention to collect some of the best facts attainable in regard to buhr milling and present them for the benefit of those who care to mill, or for the entertainment of those who are otherwise interested, we will say that nothing better can be done than to repeat what Oliver Evans had to say, as published in the earlier editions of his book.

CHAPTER LXXIX.

QUOTATIONS FROM OLIVER EVANS—MODIFICATIONS OF EVANS' DRESS—CONTROVERSY AS TO THE NECESSITY FOR A MILLSTONE DRESS.

From these principles and ideas, and the laws of central forces, I form my judgment of the proper draught of the furrows and the manner of dress, in which I find but few of the best millers to agree. Some prefer one kind, and some another, which shows that this necessary part of the miller's art is not yet generally well understood. In order that this matter may be more fully discussed and better understood, I have constructed Fig. 2. *AB* represents the eight quarter, *CD* the twelve quarter, and *EA* the central dress. Now we observe that in the eight quarter dress the short furrows at *F* have about five times as much draught as the long ones, and cross one another like a pair of shears, opened so wide that they will drive all before them, and cut nothing; and if these furrows be deep they will drive out the meal as soon as it gets into them, and thereby make much coarse meal, such as middlings and shipstuff or carnel. The twelve quarter dress appears to be better; but the short furrows have about four times as much draught as the long ones, the advantage of which I cannot yet see, because if we have once found the draught that is right for one furrow, so as to cause the mea

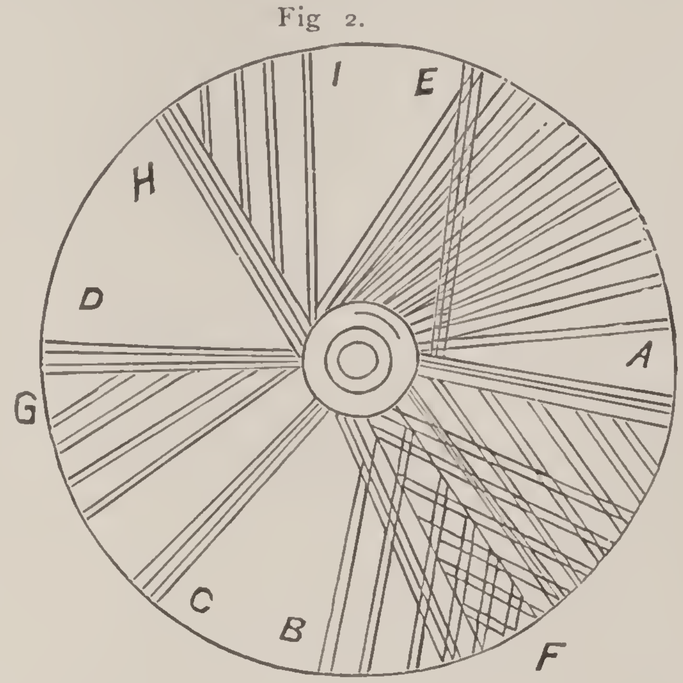
Fig. 2.



to pass through the stone in a proper time, it appears reasonable that the draught of every other furrow should be equal to it.

In the central dress *EA* the furrows have all one draught, and if we could once determine how much is necessary exactly, then we might expect to be right, and I presume we will find it to be in a certain proportion to the size and velocity of the stone; because the centrifugal force that the circular motion of the stones gives the meal, has a tendency to move it outward, and this force will be in inverse proportion to the diameter of the stones, their velocities being the same by the fourth law of circular motion. *Ee* is a furrow of the running stone, and we may see by the figure that the furrows cross one another at the center in a much greater angle than near the periphery, which I conceive to be right, because the centrifugal force is much less nearer the center than the periphery. But we must also consider that the grain, whole or but little broken, requires less draught and central force to send it out than it does when ground fine, which shows that we must here differ in practice from the theories founded on the laws of circular motion and central forces; because, the grain as it is ground into meal is less affected by the central force to drive it out, therefore the angles with which the furrows cross each other must be greater than the verge or skirt of the stone, and less near its center than assigned by theory, and this variation from theory can be formed only by conjecture, and ascertained by practice.

Fig 2.



From the whole of my speculations on this difficult subject, added to my observations on my own and others' practice and experience, I attempt to form the following rule for laying out a five-foot millstone:

1. Describe a circle with 3 inches, and another with 6 inches radius, round the center of the stone.

2. Divide the 3 inches space between these two circles into 4 spaces, by 3 circles equi-distant; call these 5 circles draught circles.

3. Divide the stone into 5 parts, by describing 4 circles equi-distant between the eye and the verge.

4. Divide the circumference of the stone into 18 equal parts, called quarters.

5. Then take a straight-edged rule, lay one end at one of the quarters at 6, at the verge of the stone, and the other end at the outside draught circle, 6 inches from the center of the stone, and draw a line for the furrow from the verge of the stone to the circle 5. Then shift the rule from draught circle 6, to the draught circle 5, and continue the furrow line toward the center, from circle 5 to 4; then shift in the rule to draught circle 4, and continue to 3; shift to 3 and continue to 2; shift to 2 and continue to 1, and the curve of the furrow is formed, as 1—6 in the figure.

6. To this curve form a pattern to lay out all the rest by.

The furrows with this curve will cross each other with the following angles as shown in Fig. 1, at circle 1, which is the eye of the stone, at 75 degrees angle, No. 2 at 45 degrees, No. 3 at 35 degrees, No. 4 at 31 degrees, No. 5 at 27 degrees, and No. 6 at 23 degrees.

These angles, I think, will do well in practice, will grind smooth, and make but little coarse meal, etc., as shown by the lines, *G r*, *H r*, *G s*, *H s*, etc.

Supposing the greatest draught circle to be 6 inches radius, then by theory the angles would have been at circle 1, at 138 degrees angle, No. 2 at 69 degrees, No. 3 at 46 degrees, No. 4 at 34½ degrees, No. 5 at 27½ degrees, and No. 6 at 23 degrees.

If the draught circle had been 5 inches radius, and the furrows straight, the angles then would have been at circle 1 about 180 degrees, and 6 inches from the center, as shown by lines *G*1, *H*1, 110 degrees; No. 2 at 60 degrees, No. 3 at 38 degrees, No. 1 at 29 degrees, No. 5 at 23 degrees, and No. 6 at 18 degrees.

The angles near the center here are quite too great to grind; they will push the grain before them; therefore, to remedy all these disadvantages, take the aforesaid rule, which forms the furrows, as shown at 6—7, Fig. 1, which is 4 of 18 quarters. *H* 8 represents a furrow of the runner, showing the angles where they cross those of the bed-stone, in every part. Here I have supposed the extremes of the draught to be 6 inches for the verge, and 3 inches for the eye of the stone, to be right for a stone 5 feet in diameter, revolving 100 times in a minute;

but of this we cannot be certain. Yet by experience and practice the extremes may be ascertained in time for all sizes of stones, with different velocities, no kind of dress that I can conceive appearing to me likely to be brought to a truth except this, and it certainly appears, both by inspecting the figure, and reason, that it will grind the smoothest of all the different kinds exhibited in the plate.

The principle of grinding is partly that of shears clipping. The planes of the face of the stones serving as guides to keep the grain, etc., in the edges of the shears, the furrows and pores forming the edges; if the shears cross one another too short, they cannot cut. This shows that all strokes of the pick should be parallel to the furrows.

To give two stones of different diameters the same draught, we must make their draught circles in direct proportion to their diameters; then the furrows of the upper and lower stones of each size will cross each other with equal angles in all proportional distances, from their centers to their periphery. But when we come to consider that the mean circles of all stones are to have nearly equal velocities, and that their central forces will be in inverse proportion to the diameters, we must consider that small stones must have much less draught than larger ones, in proportion to their diameters.

It is very necessary that the true draught of the furrows should be determined to suit the velocity of the stone, because the centrifugal force of the meal will vary, as the squares of the velocity of the stone, by the fifth law of circular motion. But the error of the draught may be corrected in some measure by the depth of the furrows. The less the draught the deeper the furrow, and the greater the draught the shallower must the furrows be to prevent the meal from escaping unground. But if the furrows be too shallow, there will not be a sufficient quantity of air pass through the stones to keep them cool. But in the central dress the furrows meet so near together that they cut the stone too much away at the center unless they are made too narrow; therefore I prefer what is called the quarter dress, but divided into so many quarters that there will be little difference between the draught of the furrows. Suppose 18 quarters in a five-foot stone, each quarter takes up about 10½ inches of the circumference of the stone, which suits to be divided into about four furrows and four lands, if the stone be close, but if it be open, two or three furrows to each quarter will be enough. This rule will give 4 feet 6-inch stones 16, 5 feet 6-inch stones 21, and 6-feet stones

25 quarters. But the number of quarters is not so particular, but better more than less. If the quarters be few, the disadvantage of the short furrows crossing at too great an angle, and throwing out the meal too coarse, may be remedied by making the land widest next the verge, thereby turning the furrows toward the center, when they will have less draught, as the quarter *H I*, Fig. 2.

This may be said about the sickle dress which Evans suggests, that where there is the small proportion of skirt which is now used, say about 9 or 10 inches on a 48-inch millstone, that the sickle curves are hardly necessary. The difference in the angle of their contact is hardly sufficient to justify the use of such a dress. However, a uniform draught under any circumstances should be used, and upon the general principles which he outlines. Should we develop the sickle draught, if we connect a line 9 inches from the periphery of the stone with one at that point, we would have a proper draught. Or to express this another way, for the sake of clearness: Say we connect the two ends, the outer and the inner, of the furrow, with a straight line.

Those who have read Professor Kick's book, or translations from it, will probably remember an account of a controversy among some Hungarian millers in regard to drafts of millstones. We here present the facts as they are given:

In 1873 Franz Schmid made the experiment in Lanzendorf of grinding with the runner reversed in direction, and could not notice much difference in the ground material as to quality or quantity.

This trial caused further examinations, and October 6, 1877, in the mill of Adalbert Hlavaê, in Podiebrad, the matter was carefully tested. The stones used were French buhrs, with a diameter of 1.1 metres, and were divided in twelve quarters. The draft circle measured but eight centimetres in diameter, and every quarter had three furrows parallel to each other. Diameter of the eye of the stone, 26 centimetres; width of grinding surface, 19 centimetres. The shape of furrows and balance of stone were in perfect order. Three hundred litres (a litre is equal to about one quart) of first reduction stock was reduced to second reduction, which resulted in:

Regular direction of upper stone—Flour, 19.5 kilogrammes, 6 per cent; fine middlings, 10.2 kilogrammes; coarse middlings, 22.8 kilogrammes; temperature, 23° C.

Opposite direction of runner—Flour, 25.9 kilogrammes, 8 per cent; fine middlings, 8.8 kilogrammes; coarse middlings, 30 kilogrammes; temperature, 25–26° C.

Coarse remnants were more broken.

CHAPTER LXXX.

REDUCTION OF MIDDLINGS IN 500-BARREL MILL—SEPARATION OF REDUCED STOCK—CLOTHING OF REELS—REDUCTION OF SECOND MIDDLINGS.

Now to take up the reduction of the middlings by the millstones: We will presume that the grinding has been of the character that was previously described; that is, as high as can be to produce good flour and full length of the flour cloth on the first middlings reel. There are three 48-inch millstones for this purpose. This will admit of the possibility of the facing of one of them as it may be required, though better grinding will be done by the three of them at once. On the tail of the first reel it will be noticed that there is a No. 8 cloth, and if the grinding be of the proper character, there will be nothing but rough tailings pass over its tail. Also, there will be a proportion of this grade of stock pass through the No. 8 cloth near the tail, which may be run to the rough tailings by closing slides under that conveyor. Again, any portion of the product of the No. 14 cloth, or of the No. 8 cloth, may be run into the reel immediately below by opening slides. It may not always be desirable to take flour the full length of the upper reel, even if the flour is clean and bright during the full length of the flour numbers on that reel. It may be desirable that the proper softness of material be preserved in the second reel in order that the flour from that reel be sufficiently bright and clean, as well as on the reel immediately under it. If all the flour were taken out which it is possible to remove on the first reels, it might be found that the flour which came from the second reel, or quite a proportion thereof, would be rather ragged and red in character. The No. 9 cloth which is on the tail of the second reel admits of the reduction of a proportion of soft material which goes into the third reel and at the same time conveys stock to the second dust middlings. Now, as the original middlings were No. 7, and as there was a reduction by the millstone, the stock which passed over the tail of this No. 9 cloth would still continue to contain branny, impure stock, and possibly a portion which went through the No. 9 cloth would also

be of the like character, but this material could be kept up in quality, if desirable, by taking less flour from the first reel.

The cut-off and tail from the last flour reel is second middlings. Their reduction is accomplished by the use of three 9x14 smooth rolls. The stock having been reduced on the millstones, it is now in a condition to be again taken up by smooth rolls, and it is particularly desirable that this be done, for the reason that the stock will hardly be so pure as second middlings as it was as first middlings, notwithstanding the fact that it has been scalped twice since its reduction. This is true for the reason that the proportion of middlings to impurities has been reduced. There are absolutely less impurities in the second middlings than there were in the first middlings; relatively the proportion is larger, that is, there are less middlings, but proportionately more impurities. The reduction of the middlings by this amount of grinding surface will pulverize a larger proportion of the material which it is desirable to pulverize or reduce, and leave whole or intact that portion which is desirable, in the impurities. The tail of the No. 10 cloth will not be of as poor a quality as was the tail of the No. 8 cloth on the first middlings reel, and the proportion of soft material which goes into the second reel may be regulated in the same manner as was described for the first middlings stock. The product of all the reels of the first and second middlings is patent flour. The tail and cut-off from the last second middlings reel is first dust middlings, or it might be called third middlings, excepting that the stock is of the same general quality as the first dust middlings, and is run in with that grade of stock.

CHAPTER LXXXI.

BREAK FLOUR REELS FOR 500-BARREL MILL—SEPARATION OF STOCK—FIFTH BREAK OF 500 BARREL MILL—CLOTHING OF REELS AND SCALPERS WHICH FOLLOW—SIXTH BREAK ON 500-BARREL MILL—CLOTHING OF REELS AND SCALPERS WHICH FOLLOW—A SEVENTH BREAK.

The break flour reels, as here designated, handle the stock of the middlings scalpers from the second, third and fourth breaks. The fifth break stock is handled by itself. The head number is 12, as usual, and the tail number on the first reel is 8. The tail of the No. 8 is a proper grade for the third dust middlings. The second reel is clothed on its tail with No. 9, and the tail of the No. 9 is of the proper quality for the second dust middlings. The cut-off from the first scalper is sent in the same direction. The clothing of the second reel is Nos 12 and 14. The quality of the product of the No. 12 cloth may be regulated by the proportion of the material which is cut off from the upper reel. If the stock which goes through the No. 9 cloth of the second reel should be too soft, it would remain to take more flour from the first reel, or if it were too sharp, it would take less flour from the first reel. Objection might be raised to the fact that we take a certain proportion of the No. 9 cloth product and send it with the second dust middlings rather than with the first. But it may be said that the object in this case is to keep the first dust middlings as bright and as clean as possible, and again, that the quality of this stock which goes to the second dust middlings can be regulated at will by the miller by the adjustment of the slides under the scalpers. The clothing of the third reel is with Nos. 14 and 16, which will admit, under ordinary circumstances, and the proper treatment of the reels above, of taking the flour the full length of that reel: or, if not its entire length, most of it. There is a disposition to reject No. 16 cloth by many millers. In some instances, in fact most instances, this would be right, but here where the stock would probably be tolerably thin toward the last on the bottom reel, the product of the No. 16 cloth would be no finer than No. 14 cloth on the reel above, and it is desirable to get as much flour as we can from any set of rolls,

though not always to get as much as we can from any one of them. For that reason we arrange on the bottom reel so that the flour may be taken a greater portion of its length, thus admitting of a judicious scalping upon the reels above. The tail and cut-off from the last reel is dust middlings. If the dust middlings product should be too soft, all that would remain to do would be to take a spout from the tail of the bottom reel of the third flour reel conveyor and run it into the elevator of the first dust middlings chop. This would take the flour out of the dust middlings and send it into the flour reels, that is, it would cut it round the rolls. If there should be any trouble in the feeding of the first dust middlings rolls, it would be on this account. Wherever there is such trouble, it indicates that there is too much flour stock running into the other material, and, as we know, if such flour stock be taken out and rebolted, in the reels of the rolls to which it was originally run, all of this trouble would be obviated.

As the fifth break product is treated by itself, we will consider the reductions and separations given, and it would be well if the reels which handle the product of that reduction were to be arranged as here shown, that is, one above the other. It would be convenient to inspect all grades of stock in immediate proximity one to another. We show No. 6 rolls handling this grade of material. They are 9x18 inches in size, and have twenty corrugations to the inch. It is a usual thing to decrease the number of rolls and the proportion of grinding surface at this stage of the process, but it is a wrong thing to do. If any change is made, the proportion should be increased. It is difficult enough to get flour of the proper quality and middlings of a sufficiently high grade to work into patent flour from this reduction, and it is especially difficult to do so when the proportion of grinding surface is reduced. The first scalping reel is clothed with No. 34 grits gauze, which is equivalent to No. 0 bolting cloth. The tail of this scalper goes to the sixth break in the usual manner, and the break goes into a scalping reel. The head of the scalping reel is clothed with No. 7 cloth, and the tail numbers, as shown, are 4 and 2. The tail of the No. 2 goes to the rough tailings, as does any proportion of the product of the No. 2, while the product of the No. 4 goes to the fine tailings purifier. This arrangement prevents the possibility of waste of good material. If the middlings are of proper grade to go into patent flour, they may be sent in that direction, and if not, they may be sent around the purifiers into the rough

tailings. Even if their character is questionable they should be sent to the purifiers and their grade elevated thereby. The product of the No. 7 is sent into the flour reel immediately below this middlings scalper, which is clothed with No. 12 at the head. It is not necessary to take any more than a very small proportion of flour from this reel. The scalping number is 6, which is one number coarser than the scalping number on the reel above. The tail of the No. 6 may be sent to the first low grade, and the desirable portion of the product of this scalper may be sent to the third dust middlings. The cut-off from the No. 12, and the cut-off from the scalping product, is sent into the reel below, which is clothed with Nos. 14 and 16. The tail of the No. 16 is sent to the second dust middlings, and the cut-off from the flour reel is sent to the third dust middlings flour reel. This is for the purpose of preventing the third dust middlings from being too soft, and as this stock is very fine, it will find its proper place in this reel, and prevent liability of waste, in that it will go through the proper flour numbers at the proper time.

The sixth break has the same number of rolls and the same amount of grinding surface as does the fifth break. The corrugations are twenty-four to the inch. This number for this break seems to be a fixed fact. No one appears to question the desirability of using a coarser or finer cut roll. The product of the sixth break rolls is scalped on a centrifugal which is 8 feet long, and which is clothed with No. 36 wire. No. 36 wire is equivalent to No. 1 cloth. The action of the centrifugal on bran stock is like that of a bran duster, and after the material has passed over the tail there is no need of sending it to the bran duster. All has been done for it that can be done by the action of the centrifugal. There are two conveyors under this centrifugal reel so arranged that the tail portion of that reel may be sent direct to rough tailings, and thus keep them out of the scalp reel below. The product of the upper conveyor is sent into a flour and tailings scalping reel below. This reel is 16 feet long. The product of the No. 8 cloth is sent into the flour reel, while any portion of the No. 4 cloth may be sent to rough tailings. The tail of that reel is also sent to the rough tailings rolls. Thus we will have coming to the rough tailings, material which will tail over a No. 8 and pass through a No. 1, but it is a low grade of material. Still there are nubs and other stock which lie between the corrugations of the

rolls which contain a certain proportion of flour, and which will be reduced by the rough tailings rolls. After having passed through the No. 8 cloth, this stock is sufficiently soft to bolt nicely on the reel below. In the case of its being very soft, if it should not bolt free enough, it is entirely possible to run in a little of the stock which passes through the No. 4, and thus liven it. The product of the Nos. 12, 14 and 16 cloth of the flour reel is first low grade flour. On winter wheat it would be of a grade equivalent to three-eighths St. Louis standard, that is, first-class low grade flour, a grade next to family. It is a mistake to send this flour in with the other low grade, in that it is worth more money. The tail and cut-off from this flour reel is sent to the first red-dog.

None of the diagrams which have been presented have ever shown a seventh reduction of the wheat. The reason for this has not been that seven reductions were not better than six, but from the fact that six reductions are all that are usually considered, and that seven reductions or more are often considered unnecessary from a commercial standpoint, and might be considered as a finicky exhibition on the part of one who would seriously advocate their use. Now at the risk of being considered too particular, the writer will say that if six reductions are necessary on spring wheat—and we know that six reductions are used, and for that reason may be considered necessary—that seven reductions are equally necessary on winter wheat, for the purpose of getting all the flour out of the wheat, which means getting all the money out of the wheat, that is possible. The writer has no hesitancy in saying that better results, better flour, more of it, and more money will be made by seven reductions than by six or any less number. However, seven reductions should not be attempted on a small mill, for the reason that the temptation to run the stock in with other material for the purpose of making the separations would be too great to be overlooked, in most instances. In a mill of any size where there are seven reductions, the stock should be scalped and bolted on entirely separate reels, as much as if it were a mill by itself. It should have no connection with the other stock except through the means of the intermediate stocks. There would be first red-dog stock and second red-dog stock; otherwise, nothing which belonged in any other part of the mill. In the smaller mills there is a tendency to attempt to work this material in with other stock. The

product of the seventh reduction would probably be run in with the sixth, and the sixth is often mixed in with other higher grade products. Now while the seventh reduction is desirable, we will repeat by way of emphasis that it ought to be handled entirely by itself—have no connection with any other product, other than in the way mentioned.

CHAPTER LXXXII.

FIRST DUST MIDDLINGS—REDUCTION AND SEPARATION OF DUST MIDDLINGS—SECOND DUST MIDDLINGS—ROUGH TAILINGS—PURIFICATION, REDUCTION AND SEPARATION OF ROUGH TAILINGS—RED-DOG—ORIGIN OF RED-DOG STOCK—GRADING OF RED-DOG STOCK—SECOND RED DOG—REDUCTION OF RED DOG BY MILLSTONES—FLOUR FROM RED DOG REDUCTIONS.

The first dust middlings, which is composed of the tail and cut off from the last second middlings reels, the tail and cut-off from the last break flour reels, and the cut-off from the purified tailings flour reels, is all stock which will pass through a No. 9 cloth, and considering the material from which it was produced, it will be a stock of most excellent character, the flour from which will be of a character next to patent in quality. The only reason that the dust middlings are not purified by the ordinary means is that the middlings are too fine, and the only purification there is for them is through the means of their gradual reduction by rolls, and of the scalping of the material, which may be done from the reduced stock. The product of the reduced middlings, which is by means of smooth rolls, is sent on a reel clothed with Nos. 12 and 14 cloth, and a tail of No. 8. Now while the middlings have all passed through a No. 9, and at the same time that the No. 8 tail scalper is coarser than the original number through which they passed, it will be found that a certain proportion of material will pass over the tail of this No. 8, for the reason of its flattening by the roller reductions, and this will occur, however careful that reduction may be. There will be a little material which it would be well not to send over the tail of this reel, however. That little will be unavoidable. At the same time that there will be some good stock pass this way, there will be much that would properly belong with the rough tailings, in which direction it is sent. The stock which passes through the tail of this reel will probably be of a character to justify its passage in the same direction. Often all can be sent into the lower reel, in which event it will either be flour or second dust middlings. In previous chapters a great deal has been said

about dust middlings, and much that should be known and understood by those who mill. But it is hardly in place to repeat it here. For that reason we will drop their consideration and take up the second dust middlings.

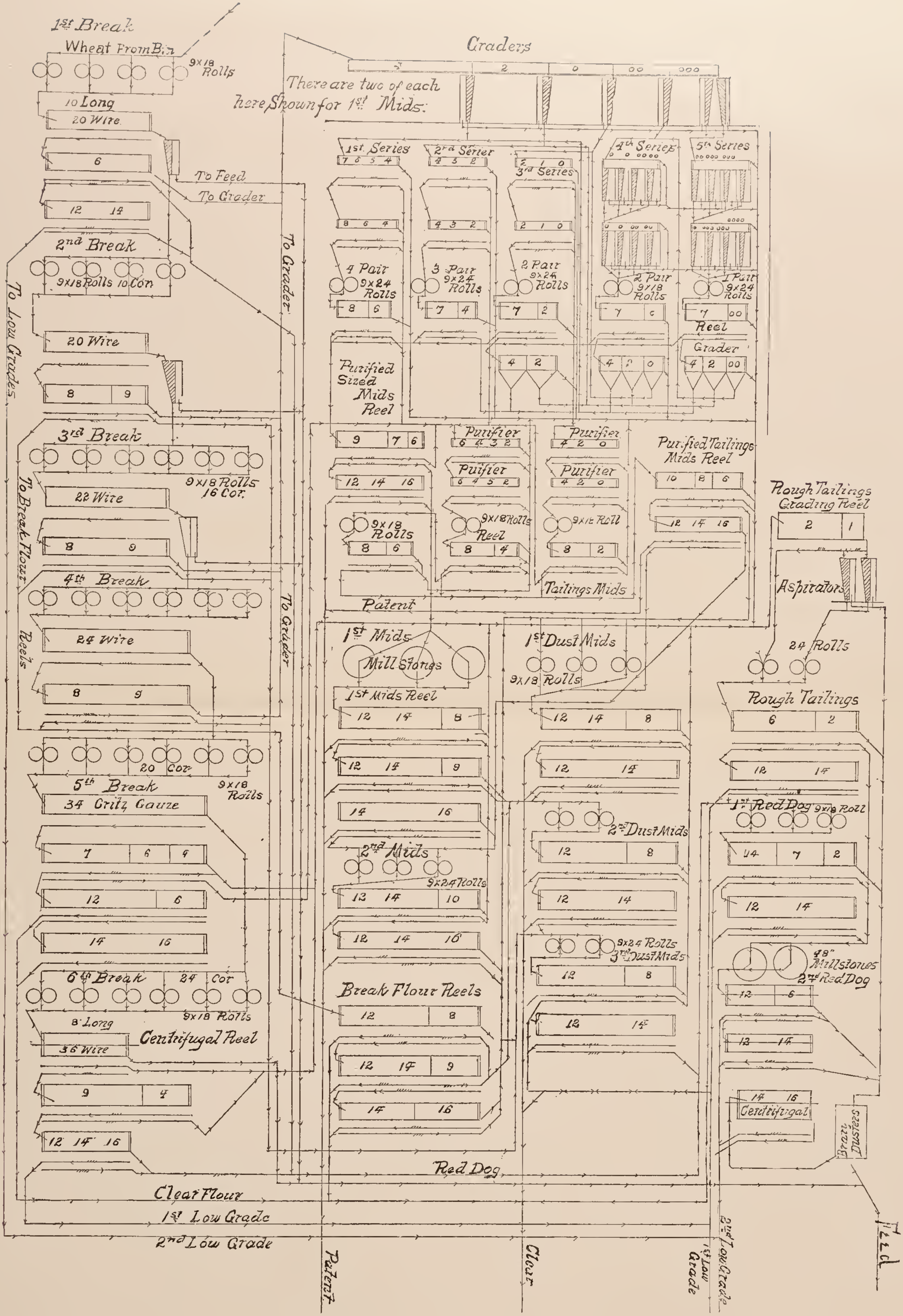
The second dust middlings is reduced upon two pairs of 9x18 rolls, and is of a material next in quality to the first dust middlings, and we will say here what might have been said in regard to first dust middlings, that the reduction should be considered as a sizing operation. More flour will be made in this way than by a close reduction, for, if we consider, we will remember that all of the stock which goes on to these rolls is fine—most of it next to flour in size, most of it that which will pass through a No. 9 cloth, some of it that which will pass through a No. 10 or 11 For that reason very little reduction is required; it should be merely a sizing operation, and not a squeezing or mashing. The arrangement of the reels for the reduction of this second dust middlings is like that shown for the first dust middlings, excepting that there is no No. 14 cloth on the first reel.

The third dust middlings rolls are 9x14 inches in size, and handle a grade of stock less uniform in size than that of the first and second dust middlings. It contains a small proportion of material which, in some instances, is a little coarser. It is next to the first red-dog stock in quality, though the flour produced is relatively a good deal higher in quality. The size of the rolls admits of a very careful and very good reduction. The clothing of the reels is exactly the same as that for the second dust middlings, with the same general purpose in view; therefore, we need not repeat what has been said with reference to that purpose. A switch path is shown from the flour break of the third dust middlings, which indicates that the flour may be sent either to the first low grade or to the clear flour.

In considering the rough tailings product, we will have in mind that what has been said in regard to the production of this stock has been carefully read and considered, and for that reason we will not recapitulate or consider anything that has gone before, only remembering that it is a rough, branny grade of stock, which contains a good deal of bran and quite a proportion of fine soft material which would be sent to feed excepting that there is mixed with it other better material, and it is altogether a stock of very low character. We send this material into a reel to be graded, for the reason that it is hardly possible to grade it as

it is produced. This reel is clothed with No. 2 cloth at the head, and No. 1 at the tail. Whatever passes through the No. 2 cloth is sent to one pair of 9x14 rolls, and whatever passes through the No. 1 cloth is sent to an aspirator, and the stock which passes over a No. 1 cloth, to another aspirator. From this material will be drawn out quite a proportion of fine bran. We will say here that it would be well to attach a slight suction to the grading reel as well, which would also take out some of this material. The bran which would be taken out from these aspirators will be so thin and light that it will be sent to the feed. This whole apparatus is simply for purifying purposes, a means of the purifying of the rough tailings in so far as that operation is possible, excepting as it is continued by the use of the smooth rolls. These rolls crush this material, which has been freed from all the light, fine, branny matter which would otherwise be pulverized and run into the flour, and it passes into the first reel, which is clothed with Nos. 6 and 2 cloth. The tail of the No. 2 goes to the bran duster, as does any desirable portion of the product of that cloth. The product of the No. 6 goes into a reel clothed with Nos. 12 and 14, which produces first low grade flour, or in some instances this might be run in with the clear flour. The cut-off from that reel may be sent directly to the second low grade or into the first low grade reels, or to the first red-dog rolls, as shown; though it must be borne in mind that whenever this stock is soft enough to make the first red dog roll feed badly, then it is soft enough to be run in with the flour, or, if not that, it should be sent around the rolls and into the reels.

The origin of first red-dog stock has been duly considered in the past, and is a stock intermediate between third dust middlings and the finer red-dog stock. It is a grade of material which will produce XX or XXX flour, and which should pass to the same grade as that produced by the sixth reduction rolls. There is a short piece of No. 14 cloth at the head of the first reel, which separates the first reduced red-dog stock, and then there is a piece of Nos. 7 and 2 at the tail. The tail of the No. 2 may be sent to the feed, the product of the No. 2, the second red-dog and the product of the No. 7, and the cut-off of the No. 14 to the second reel. The flour product of course goes to the first low grade, and the cut-off and the tail from the second grade goes to the second red-dog buhrs. There is nothing better for the second red-dog reduction than the millstones. They should have about 4 inches draft



FIVE HUNDRED BARREL MILL.

and run about 130 or 140 revolutions a minute; should be dressed so as to reduce the stock, and should be run strictly for that purpose. This reduction should be regarded as the last chance, and the most should be made of it. The flour will be low in grade under any circumstances. The rolls could not reduce this material. They would make very little flour. The stock would be too flat. It would be much like grinding feathers. Nothing but a millstone will have much effect upon it. The course of the stock is clearly shown in the diagram. One millstone would do most of the work. Two are necessary, in order that one may be taken up from time to time for the purpose of cracking, with good, heavy, well-defined crackers. The bran duster takes all of the feed stock excepting the tail of the sixth reduction scalper; that is, it takes everything except the bran. It is really a fine feed duster rather than a bran duster. It should be clothed with about No. 110 wire, which is equal to about No. 10 cloth. The product should be sent to a centrifugal reel, for the purpose of rebolting the stock. The flour will be sent to the low grade, and the cut-off back to the red-dog. This is the only return we have in the mill.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